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Vol. 47 JUNE, 1961 No. 6

WILLIAMS

Precious Metal

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- For Better-Fitting, More Functional Appliances

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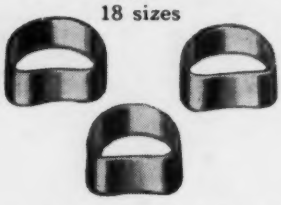
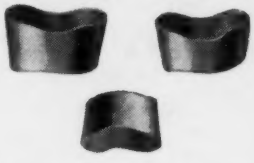
MOLAR
.006" or .007"
24 sizes

ANTERIOR
.004"
18 sizes



BICUSPID
.004"
6 sizes



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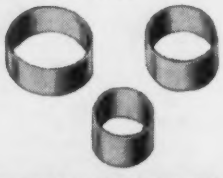

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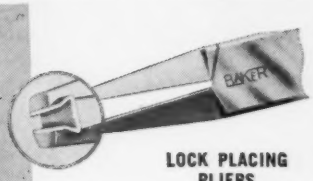
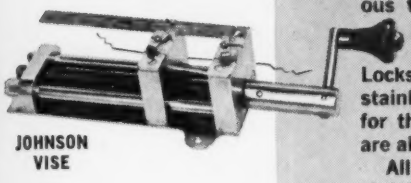


LOCK PLACING PLIERS



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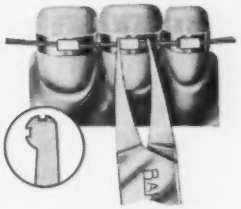
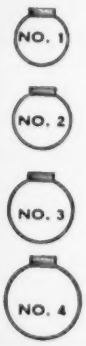


LOCK SEATING AND REMOVING PLIERS



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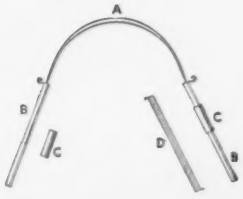

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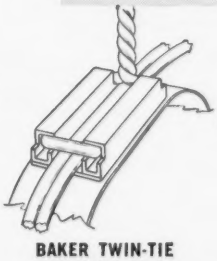

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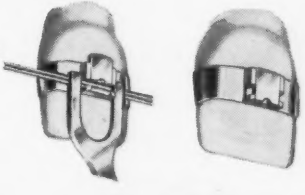

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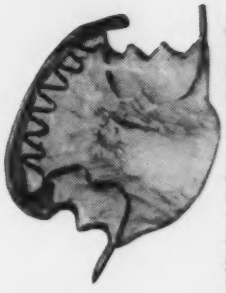

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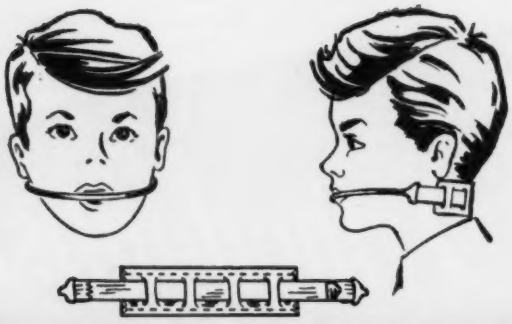

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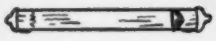

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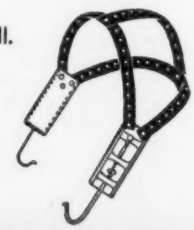

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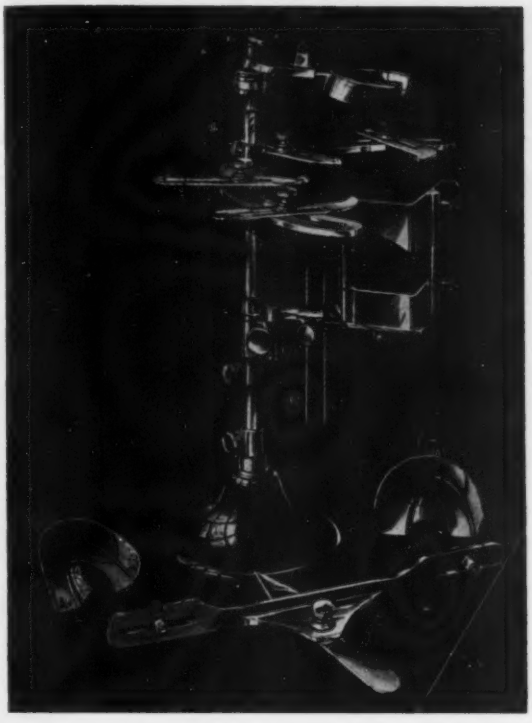

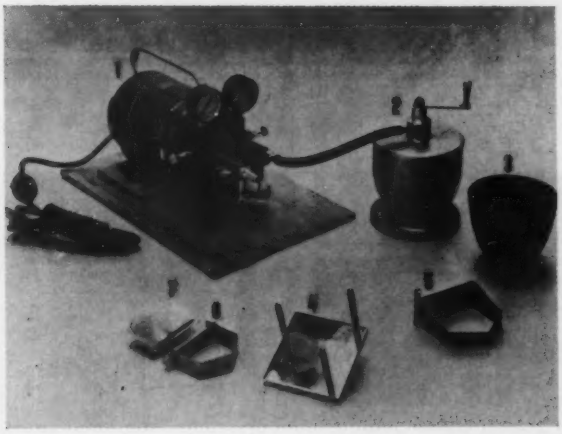

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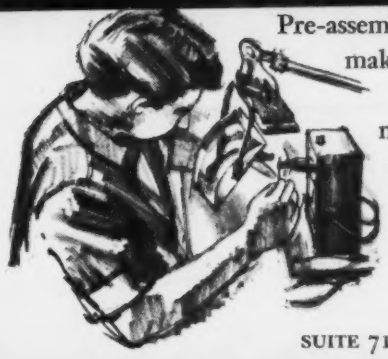

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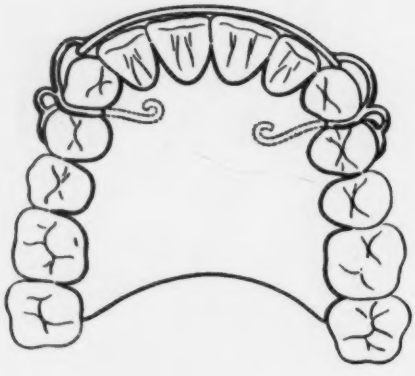

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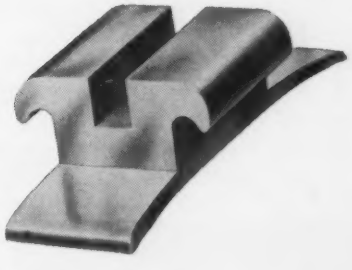

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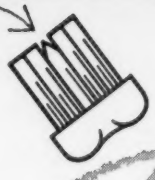

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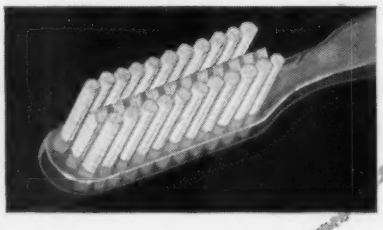

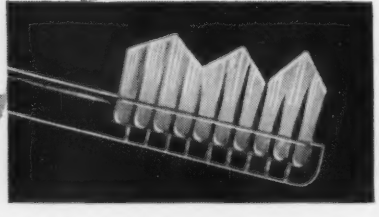

Long tufts for picking; reaches last molar.

4-row, contoured

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Lighting was the most serious problem faced by medieval devotees of the rolling bones. If a candle were placed on the gaming table, it would interfere with the fall of the dice. So, it was customary to ask some onlooker to hold the candle while gamesters played.

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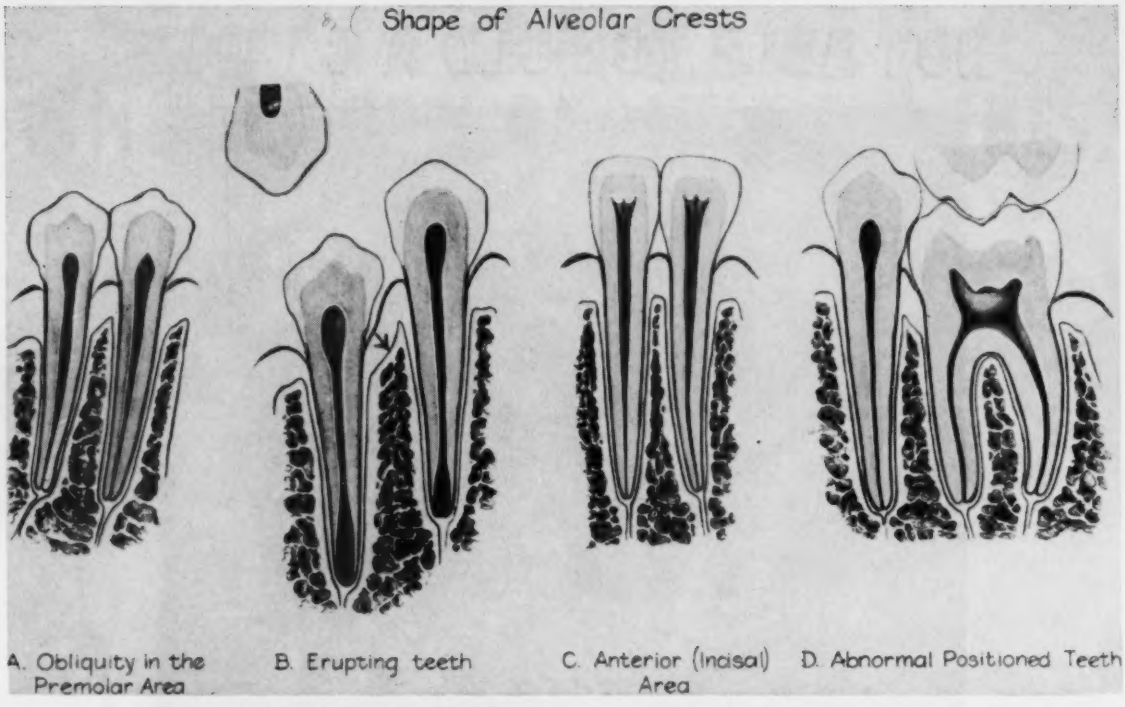
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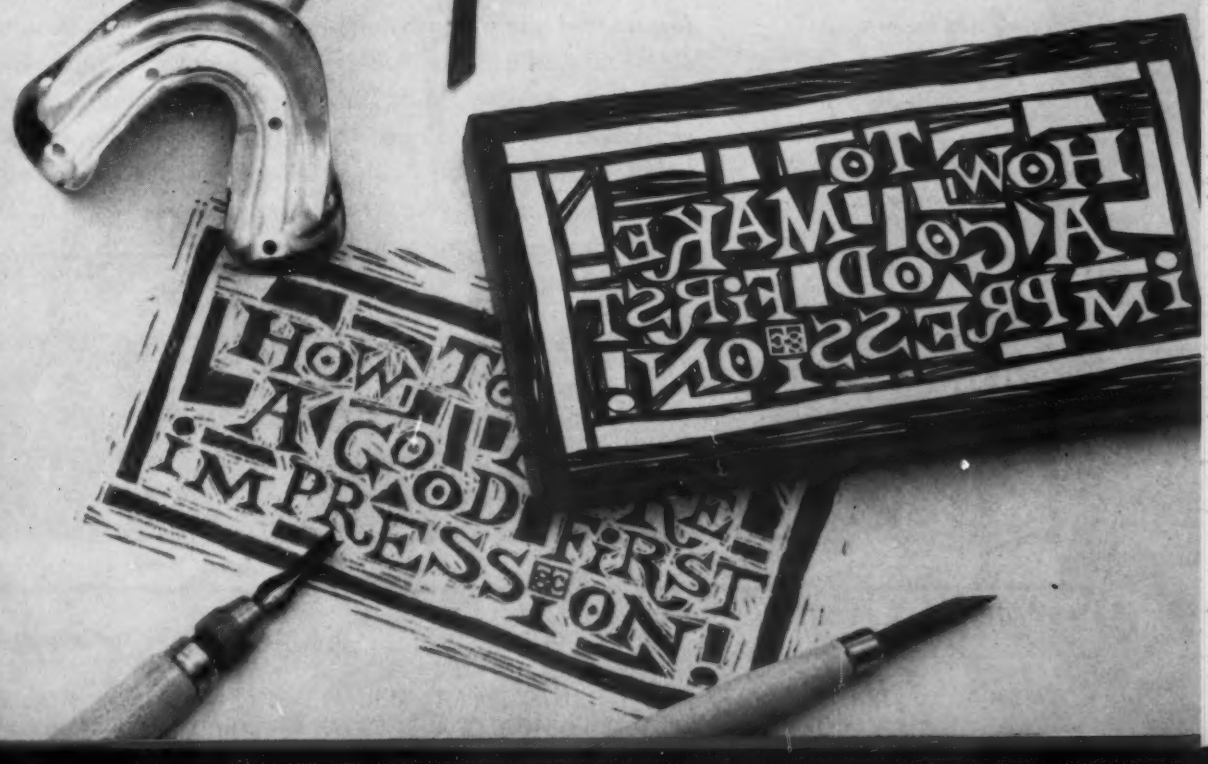

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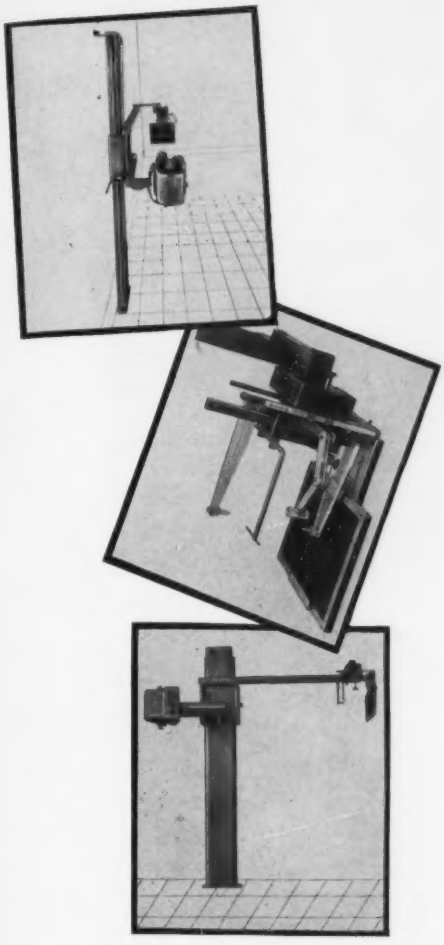

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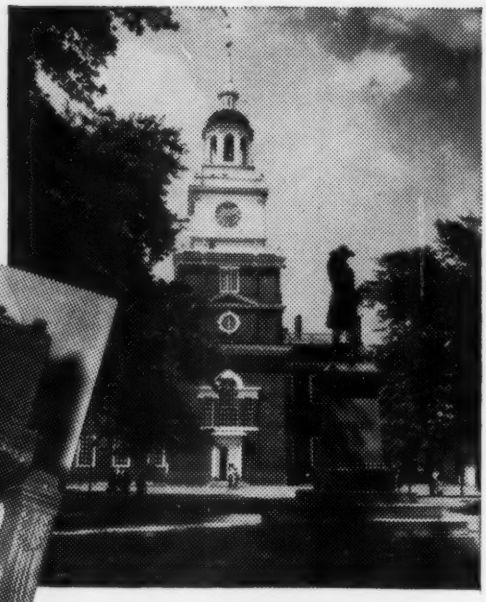

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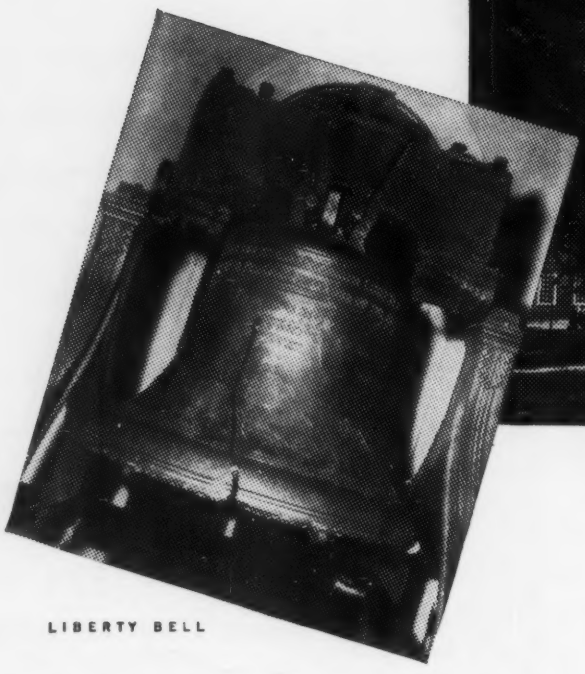

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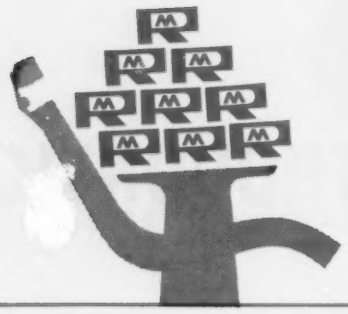

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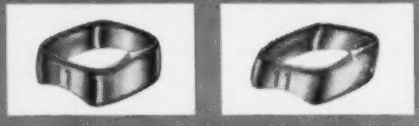

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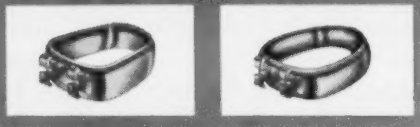

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VOL. 47 JUNE, 1961 No. 6

Original Articles

PRESIDENT'S ADDRESS, NORTHEASTERN SOCIETY OF ORTHODONTISTS

WILBUR J. PREZZANO, B.S., D.D.S., WHITE PLAINS, N. Y.

IT IS the duty of the president of this Society to deliver an address to the membership at the annual meeting each year. This address is then referred to a special committee appointed by the vice-president to examine and determine the practicality and usefulness of any recommendations or suggestions contained therein. This committee then submits its appraisal and formal recommendations at a subsequent business meeting of the Society.

The Northeastern Society of Orthodontists is a very rapidly growing body whose area encompasses some of the most heavily populated centers in our nation. Since we are the largest constituent society and therefore form almost one-fourth of the membership of the entire American Association of Orthodontists, it follows that our problems are similar to, mutual, and intermingled with those of the parent body. As George Anderson, president of the American Association of Orthodontists, told us at our October meeting, "It is quite natural that we have suffered and continue to suffer some growing pains." As he stated, these pains emanate from within and from without. It is proper and healthy that we have reasonable differences of opinion within our own group, for this is what stimulates progress and improvement. We have had differences and will undoubtedly continue to have some, but it becomes increasingly apparent that we are steadily moving toward a greater unity of constructive understanding and feeling. This gradual but steady tendency toward a firmer solidarity is becoming more obvious and will serve to strengthen our specialty and our organization, all of which is vital if we are to successfully overcome the situations that we face.

Presented at the annual spring meeting of the Northeastern Society of Orthodontics in New York, New York, March 14, 1960.

We possess a rich and proud heritage that has placed orthodontics at a level of high respect and regard among the older health services and preventive arts. For this, we shall be eternally indebted to the early practitioners of orthodontics and, as members of this Society, to our founders. It is for us, every one of us, and for the orthodontists of the future upon whom we shall have a great influence to uphold and to carry on with the same standards of deep sincerity, interest, and ethics that have been set for us by our predecessors.

What demands of future progress confront our immediate situation? We must continue to build an ever stronger, finer Society. The officers and committeemen of your Society sacrifice much time and infinite energy toward the purpose of making this a better organization for all of us. The recent increase in size of our group has naturally brought greater demands upon our administrators. Therefore, and following the theme of my immediate predecessor, Walter Bedell, we are striving constantly to work toward a more systematic, efficient organization. All of this cannot be accomplished in a short period; it requires not merely the efforts of the officers but the support and cooperation of every member as well. We wish to urge everyone to participate interestedly in the activities of the various branches and committees of this organization. Submit your thoughts, ideas, advice, and questions to the proper department, where they will be well received and fittingly acted upon. This particularly pertains to the Board of Censors. The members of that Board want to receive every bit of unbiased information possible about a prospective member so that they may accurately make their judgment and recommendations. It is not your privilege but your duty to supply this information. This is merely an example of what should be done; the same holds true of all branches of the Society. Your officers and committeemen are only human. They need your help, and when they take an action they justifiably expect your support.

In order to give full opportunity for thorough consideration of the business affairs and activities of our growing group, we have had to extend the Sunday executive council meeting to an all-day session. Although this has meant greater personal sacrifice for the members of the Council, in both time and expense, the plan has proved to be most worth while. With our ever-increasing growth, the duties of our future administrations will continue to become heavier and if we are to ably operate toward the purposes for which we were originally intended, more frequent meetings of committee and officers will be necessary.

Our parent group, the American Association of Orthodontists, is also making efforts to meet the demands of increasing growth. It is envisioned that the central office of the A. A. O. must soon have full-time professional administration. They, too, are looking to more frequent committee and board meetings, all of which involves increased expense. It is to the higher administrative authority of the American Association of Orthodontists as our national body that each sectional society, ours particularly, should conform and delegate our cooperation to the fullest extent.

What of our relationship to the remainder of the dental profession? As members of this Society we are first, last, and always dentists and members of the American Dental Association. As such, we are just as integral a part of the American Dental Association as any of its groups of members and obviously have to and wish to cooperatively support that organization which we help to form. It becomes our duty, working concurrently with the aid and guidance of the American Dental Association, to uphold the precepts of practice and treatment of orthodontic patients so that the dental health of the public that we serve may be properly safeguarded. As you know, any licensed dentist in the area of our Society has the legal right to practice orthodontics and even to proclaim himself a specialist without spending one hour in a university postgraduate course or as a preceptor in the office of a specialist. The medical profession can restrict its specialties by making limitations in hospital privileges. We have no such control, as the major portion of dentistry is carried on in the private office of the practitioner and there he can do anything within any field of dental practice. Many thousands of children right here in our own area are undergoing so-called corrective orthodontic treatment that is being conducted by men who have not had one bit of special training for that purpose. In many such instances, these dentists do not and cannot render a competent service. It is our responsibility, directly and through the American Association of Orthodontists, to work constantly toward the correction of this situation under the directives of the Council on Dental Education and other similar authorities of the American Dental Association. This is not simple, for we have to combat inconclusive state laws, mistaken public sentiment, and misinterpretation of purpose within our own profession. In the present situation concerning requisite training and open practice, it is vital that the American Dental Association should establish a central control by which these conditions be governed and corrected.

Many of our members have had numerous requests over the last several years to participate in orthodontic courses for general practitioners. Most of these requests were from groups sincerely soliciting information on so-called preventive or interceptive orthodontics. As you know, your Society has responded and taken steps in this matter. After thorough study, a policy was formulated and a resolution was adopted at our last meeting. Therefore, an Educational Advisory Committee has been appointed and any member or school who receives a request to participate in or conduct such a course is urged to seek the guidance of this committee. The chairman is Wilbur D. Johnston of New Haven, Connecticut.

We believe that if, in all our efforts, we strive to continue to work with the same spirit of mutual respect, cooperation, and camaraderie that has characterized our specialty, we cannot fail. The stronger our specialty, the stronger is each individual member.

I should like to deviate for a few moments at this time and go to a different but not unrelated topic. It is the obligation of each one of us, and therefore the responsibility of our Society, to encourage younger men entering

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I should like to deviate for a few moments at this time and go to a different but not unrelated topic. It is the obligation of each one of us, and therefore the responsibility of our Society, to encourage younger men entering

the specialty to gain the greatest amount of knowledge possible and to achieve the finest results attainable. All of us, as individuals, can and have aided in this by encouraging young men of proper intellect, ability, and character to enter our specialty. Many of us in this room today are orthodontists largely because of the fine influence and admiration that we have had for one or more members of the specialty. I happen to be one of those. May I urge each one of you to make an ever greater effort to concern yourself with our students and recent graduates, so that they will maintain and even raise the standards of the practice of our specialty.

There are, of course, many things that the Society has done and can do toward the betterment of orthodontics. In my opinion, this Society has the means and the opportunity to enter the field of scholarship or award funds. We should approach this on a very limited basis but with a definite introductory plan which may or may not be enlarged upon later, according to experience. It is my recommendation that this Society offer an annual award to the most outstanding postgraduate student of orthodontics in one of the universities in our area. I would suggest the head and staff of each university postgraduate department in the area of the Northeastern Society submit the qualifications of one candidate of their recommendation. This could be based on written thesis or general ability and interest. An awards committee of our Society would then review these qualifications and determine, after thorough consideration and even consultation with the various heads of departments, who the recipient should be. The award made annually would be in the amount of $200.00.

This is merely one phase or type of constructive step and is meant as a start in that direction. It is my firm hope that the Reference Committee will look with favor upon this idea. A conscientious, diligent student deserves recognition and we, as a body, should help to supply that recognition in the sense of not only the financial award but mainly the *honor* connected with receiving it. I respectfully submit this to you as a recommendation and will be available to the committee for any questions as to details or workability of the plan. This will be one of my last duties as your president.

During my several years of service, I have always enjoyed the work of this Society, but the past year has been a particular pleasure. Of all the professional society duties that have been assigned to me, I am frank to say to you that none has given me greater enjoyment than serving as your president. The officers and committeemen have worked with such a magnificent spirit of cooperation and good fellowship that it has been truly inspiring. Without a single exception, everyone who was called upon to assist performed in a heartwarming, friendly, and capable manner. It would be impossible to name all these, but I do wish to mention particularly our very hard-working and loyal secretary, David Mossberg, upon whom I have called virtually more than 100 times in the last year. Also, I wish to express special gratitude to Horace Clark for all the thought, planning, and attention that he has given to the remarkably high quality of the programs that have been

presented to us. As I have said, there are others—the Arrangements Committee, the Board of Censors, the Qualifying Committee, and many other committees —to whom I owe my deepest gratitude. Naturally, we are all grateful to Mrs. Grimm for her faithful service. Finally, and in many ways most important, I wish to thank you, the individuals and many personal friends who make up this society, for your kind and wonderful support. There are few organizations that can boast such a fine caliber of membership. It has been a privilege to serve you.

Perhaps it is needless to state that, in the repose of your confidence, such responsibilities have been accepted and administered in the consciousness and gratitude of the highest honor.

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MALOCCLUSION AND CIVILIZATION

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AMONG physical anthropologists, it is common knowledge that severe malocclusions are more prevalent in civilized human groups than in most primitive populations. This difference would seem to offer a promising lead toward an understanding of why such disturbances of facial growth occur and even toward their prevention.

My own interest in this problem stems from a background in human evolution, genetics, and physical growth. Evidence from all of these fields is germane to the present discussion, and we shall deal with relevant concepts and methods from these sciences, both as they apply to lower organisms and as they may, it is hoped, be made useful in studies of man.

Deteriorations in occlusion with the development of civilization are particularly well documented for Greece by Angel[2] and for Great Britain by Keith[30] and Picton.[44] We may now ask how trends of this sort might be analyzed by a modern paleontologist.

Ordinarily, he collects enough bones and teeth to approximate ancestral and descendant forms over a manageable span of geologic time. He then measures his specimens to ascertain how quickly their size or shape evolved. One of the several units of measurement which he may apply is what Haldane[22] called the *darwin,* that is, a change in size of 1/1,000 per 1,000 years.

Skillfully used, such paleontological studies are of great value. Kurtén,[32] for example, measured the rates of dental and cranial evolution in several species of European mammals during and since the Pleistocene epoch. While the major ice sheets waxed and waned, striking evolutionary responses seem to have occurred in many species. With these rapid transformations as our standard of comparison, even the probable doubling in size of the evolving human brain during the Pleistocene was not a particularly speedy change.

In the 10,000 years or so since the last glaciation, many European mammalian species have become smaller in size. We should not automatically conclude that their gene pools have altered at the same rates. At any one time, the biggest specimens of many widespread mammalian species are often found in the coolest parts of their habitats. Newman and Munro[41] even found that the

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heaviest soldiers in the United States Army tend to be Northerners. To clinch this argument, Ogle[42] raised weanling male mice in varying laboratory conditions of temperature and humidity but on standardized dietary regimes. She showed that both the size and the body proportions of the adult animal differ in accordance with these climatic variables.

The moral of this evidence is that we should not neglect possible environmental factors in the etiology of morphologic changes in organisms over time. As we shall see, this caution has a very particular application to the evolutionary analysis of malocclusions in modern man.

Although paleontology provides many of the facts used by modern evolutionists, most of the theoretical explanations come from population geneticists. Where a clear-cut somatic change is seen in an evolving lineage of organisms, the geneticist's primary aim is to discover whether and how it has been produced by natural selection.

When a population of organisms takes over a new ecologic niche, natural selection can be expected to alter the gene frequencies of some of its alleles. Livingstone[33] believes that in man one of the likeliest changes of this kind coincided with the spread of agriculture into some of the malarial regions of the world. Especially in the Negro regions of Africa, much of the equatorial jungle is intermittently destroyed to make room for the villages and fields of the natives. Presently the soil becomes exhausted, the people move away, and jungle vegetation again claims its former domain. While the natives' clearings are exposed to the sun and rain, teeming swarms of larvae of the mosquito *Anopheles gambiae* mature in the sunlit puddles and, as adults, incessantly reinfect the people with falciparum malaria. The prevalence of this disease among the Negroes in Africa was presumably low until agriculture was introduced a few thousand years ago.

One of the human responses to falciparum malaria is apparently genetic, in the form of natural selection favoring an abnormal, so-called "sickle-cell" hemoglobin. At one autosomal locus in man, the sickling (S) gene is allelic with that producing normal hemoglobin. In Africa, most of the inland areas with hyperendemic falciparum malaria show elevated gene frequencies of the sickling allele.

In Africa, the homozygous carrier of the sickling allele usually dies in childhood of a fatal sickle-cell anemia. The heterozygote, carrying one dose of this allele, exhibits sickling of many of his erythrocytes. This genotype is apparently favored by mechanisms whose nature is still controversial.

Under the malarial conditions which formerly prevailed on the coast of British Honduras, Firschein[19] found that a heterozygous Negro mother tended to be far more fertile than a homozygous mother with normal hemoglobin. This apparent reproductive advantage of the heterozygote balanced the severe disadvantage of being an anemic homozygote and the milder disadvantage of having normal hemoglobin. In British Honduras, until recently at least, this situation seems to have attained a stable equilibrium of selective forces acting on the anemic, heterozygous, and normal genotypes. As defined for two alleles

at one autosomal locus, this situation is referred to as "genetic homeostasis" or "balanced polymorphism." Under some, but not all, conditions, such stable equilibria are also possible with several alleles and even plural loci, as shown particularly by Owen.[43]

Many geneticists suspect that programs of malaria control have probably upset the equilibrium of the sickle-cell locus in some human populations. Over several generations, observations will doubtless be made to see whether the abnormal S allele will become increasingly rare in human groups freed from hyperendemic malarial infestations.

The example of the sickling locus can advantageously lead us to a definition of the *genetic* concept of polymorphism. It is the coexistence of multiple alleles at one or more loci in a population, so that the rarest alleles cannot maintain their existing frequencies by mutation alone. It can be shown that only a homeostatic equilibrium can preserve such a polymorphism indefinitely. If selection continues long enough in a single direction, only one favored allele will remain at each locus, except where its alternatives are maintained in low frequencies by the pressure of recurrent mutations.

Now, occlusion in man is certainly an example of *morphologic* polymorphism, and very likely a person's genetic endowment has appreciable effects on his occlusion. The geneticist would like to know whether a stable equilibrium of differential fertilities and viabilities maintains this polymorphism, or whether persons with occlusal deformities leave unusually large numbers of descendants. His interest, then, centers on the relative reproductive fitness of persons with malocclusions. If natural selection really favors malocclusion in civilized man, this mechanism might help to explain its increasing prevalence since ancient times. Suitable studies of the heredity and epidemiology of occlusion in man might well settle this question.

Another very important effect of civilization on the population genetics of man has been his very prevalent hybridization. This situation has been suspected as a possible explanation of malocclusions for some years, especially since Stockard[47] produced a great diversity of occlusal anomalies in dogs by hybridizing breeds with dissimilar facial and cranial shapes.

Until almost the twentieth century, most human matings have taken place between close neighbors. In a real sense, neighborhoods were partially isolated human breeding units or populations. The average human genetic endowment was therefore somwhat inbred, with a consequent elevation of the number of genetic loci which were homozygous.

As these breeding isolates have disappeared, persons of diverse origins have mated, and presumably their descendants, on the average, are less inbred and therefore more heterozygous in their individual genetic endowments. It is possible that such hybrid persons are relatively likely to develop malocclusion. This hypothesis could easily be tested in the United States, especially by simple studies of familial aggregation of the children of recent immigrants.

Especially in the northeastern states, American children of Jewish, Irish, and Italian extraction often come from families whose places of origin in Europe are known. On a map, we may then measure the geographic separation of

ancestral birthplaces. If the "hybrid" hypothesis of the origin of malocclusions were valid, persons with the most scattered ancestries should tend toward the worst occlusions. Somewhat similar methods of defining hybridization have been used in Hulse's[26] study of the descendants of Swiss people in California and in research now in progress on Bostonians of Italian ancestry by Dr. Albert Damon and his colleagues at the Harvard School of Public Health.

One can also investigate small inbred religious groups or remote villages. Where local genealogic records are satisfactory, the amount of inbreeding can be measured for most members of the group. Inbreeding here represents how often a person traces back to a common ancestor through more than one line of descent. If the "hybrid" hypothesis of the etiology of malocclusion were true in such populations, the less inbred a person was the greater the likelihood that his occlusion would be abnormal.

On the other side of the coin of causation of malocclusion is a larger environmental element. It can best be approached by studies of somatic growth and development under both civilized and primitive conditions. Work on civilized children may yield clues as to the intrauterine etiology of malocclusion. Studies of primitive children or their skulls, on the other hand, can tell us what conditions of natural selection produced our countenances, to begin with, and how the primitive way of life to some extent inhibits the progress of malocclusion.

An unduly neglected familial aspect of malocclusion is the possible effect of maternal age and birth order. Price[45] found that when isolated, well-nourished human groups adopt the worst of civilized diets, not only do their children's teeth become carious and their faces malformed, but malnourished mothers tend to produce progeny with progressively worse occlusions from one pregnancy to the next.

Effects of maternal parity or age are not proof of poor nutrition of the mother during pregnancy or lactation, for the aging ovary in general seems to become liable to aberrations of oögenesis. This is the most likely current explanation of Mongolism, which is most common in infants born to mothers near menopause. This developmental malformation of the entire body results from the presence of extra autosomal chromatin in body cell nuclei of the person with Mongolism. Usually this extra chromatin is detached as a small extra autosome, but we now know of a few cases of Mongolism in which this material forms a translocation attached to another autosome.[13]

Now that a flood of papers on chromosomal aberrations and hereditary malformations is appearing, it would seem reasonable to find out whether recognizable peculiarities in the number, size, or shape of the chromosomes tend to be associated with malocclusion.

Still other hints as to causes of malocclusion in utero may be found as a result of studies of the finger, palm, and sole prints of persons with facial deformities. Even before the fifth intrauterine month, these prints have attained their adult configurations. According to many previous studies, as summarized by Hirsch and Geipel,[25] these prints tend to be unusual in cases of Mongolism, cerebral malformation, and even neurosis. Any such peculiarities

in persons with malocclusion would be highly suggestive of a significant prevalence of generalized disturbances of development in the early embryonic and fetal months. At the Forsyth Dental Infirmary my colleague, Dr. William E. Silver, is now actively investigating this problem.

OCCLUSION IN PRIMITIVE MAN

Much of what follows is concerned with a surprisingly neglected field—the growth of the human face under primitive conditions. Few anthropologists have published studies on children's skulls unless the skulls were very ancient fossils. Immature craniums from recent primitive tribes are scarce. Some of the finest collections are from Australian aboriginal burial sites and are housed in Adelaide and Melbourne. Several excellent studies have dealt with the collection in Adelaide, and I have worked with the Melbourne collection. Furthermore, Steadman[46] studied the occlusion of a series of aboriginal skulls from Tasmania. Among the best studies of Australian collections are works by Abbie,[1] Begg,[7] Campbell,[12] and Murphy.[37-40] Equally important studies of living aborigines still eating traditional foods have been reported by Barrett[4, 5] Cran,[16] Heithersay,[24] and Heath.[23]

Typically, the aborigine goes through a regular life cycle of changes in the facial skeleton, teeth, and occlusion, and much of this pattern can be reconstructed by assembling a suitable series of craniums from infancy to old age. This cycle seems to characterize fossil man during the Pleistocene period, as well as living primitive peoples who chew forcefully on abrasive foods and have a minimum of dental caries. What follows is a revised version of my previous account of these events.[29]

The sequence of eruption of the human dentition is not simply an inventory for painful memorization, but a pattern well adapted to vigorous mastication and extreme attrition. Ordinarily, the young infant erupts his deciduous incisors first, and in occlusion the upper teeth bite somewhat anterior to the lower teeth. The next teeth to appear are usually the deciduous first molars, and they erupt and move into occlusion almost simultaneously. In a sense, they are inborn orthodontic appliances, since their cusps interlock in occlusion, maintain the incisor overbite, and stabilize the path of closure of the jaws and the occlusion of the next teeth in the sequence, that is, the deciduous canines and second molars. At first the newly erupted teeth may be irregularly positioned in the arches, but even in civilized children this situation is usually temporary. In both aboriginal and civilized children, most deciduous arches have spaced teeth but some do not.

In most human teeth, the root or roots are narrower mesiodistally than the crown. Hard usage and attrition of the crown, however, narrow it at the zones of contact with adjacent teeth until eventually the crown may be only as wide as the roots. At the same time, the cusps are worn off and the incisal edges are ground down. During this wear, the teeth usually drift mesially, so that even in early childhood the deciduous arches of the aborigine may show appreciable reduction in their perimeters.

Even at 5 years of age, occlusal and incisal attrition may be advanced sufficiently so that more than one occlusion is comfortable for the child, and he may even prefer to bite edge-to-edge in the incisor region.

Incidentally, one of the most ancient fossil subhuman children known offers an excellent example of this stage of extreme attrition and edge-to-edge occlusion of the deciduous incisors. This skull is the original specimen of *Australopithecus africanus* from South Africa, described by Dart.[17]

As in most civilized children, the earliest permanent teeth to appear in aborigines are usually the first molars.[5] Their cusps at first lock the occlusion posteriorly, much as those of the deciduous first molars had done in infancy. Concurrently, the deciduous incisors are shed and replaced by their larger, permanent successors. These new anterior teeth show an overbite, just as their predecessors did at first, and for similar reasons. Their alignment, too, may at first be uneven.

Continuous attrition of the teeth and concomitant mesial movements of both arches allow the permanent first molars to erupt further forward in the aboriginal child than in civilized children with unworn and caries-free deciduous arches. Not many aboriginal children or adults have a marked or prolonged excess of tooth substance to be accommodated in their jaws. If such an excess temporarily crowds the teeth, this condition ordinarily is soon compensated for by attrition and by growth of the alveolar processes. In the upper jaw, an additional compensatory mechanism seems to be a widening of the arch through osteogenesis at the median palatine suture.

As adolescence approaches, the crowns of the deciduous molars are so shrunken that they occupy only about as much space as do their successors, the permanent premolars. In civilized children the premolars occupy much less space unless their predecessors have been destroyed by caries. This destruction may permit the neighboring teeth to encroach on premolar territory and to crowd the premolars themselves.

By the time the aboriginal child has shed his deciduous canines, his permanent incisors have worn enough that they need not move much to accommodate the eruption of the large permanent canines. Chiefly in the mandible, the incisors then show only minor rotations as the new canines come into occlusion, and this irregularity usually soon disappears during adolescence.

Attrition continues in adolescence, and Begg[7] estimates that about 14.7 mm. of shrinkage has occurred in the perimeter of the mandibular arch of the aborigine before the third molars erupt. As a result, these teeth are situated about where the second molars occur in civilized adolescents with complete, unworn, and caries-free dentitions.

In the aborigine, as the cusps and incisal edges of the newer permanent teeth are worn away, the occlusion again can often slide into more than one comfortable position. Even some young adults habitually bite edge-to-edge again between their permanent incisors, and most older adults prefer this occlusal position.

Thus, the sequence of events in the deciduous dentition is largely recapitulated in the permanent dentition. The cusps function mainly as temporary

guides to occlusion, and the overbite of the incisors, as seen in the so-called "normal" civilized occlusion, is a transient condition that is created whenever new and conspicuously cusped teeth first reach the occlusal plane. In other words, the Angle classification would be a hopelessly inadequate method of defining normality of occlusion in aborigines except during the period of mixed dentition.

Let us now consider the effects of other mechanical forces on the calcification of the roots of erupting teeth, and the timing, speed, and distance traversed by these teeth through the alveolar bone of primitive and civilized jaws. At the Forsyth Dental Infirmary my collaborator, Dr. Elizabeth A. Fanning, has studied these problems mainly from serial lateral jaw films of children enrolled in a longitudinal growth study at the Harvard School of Public Health.[48, 49]

These radiographs indicate that the amount and timing of mineralization of the root or roots of a calcifying tooth are independent of the degree of obstruction which the tooth may encounter during its eruptive movements. The shape of the root or roots, however, is apparently somewhat modifiable by the pathway of eruption, particularly in the third molar.

Several kinds of barrier may obstruct eruption. A neighboring tooth may intervene, or two adjacent teeth may converge on each other to block the pathway of the erupting crown. If a deciduous tooth is extracted some years before the normal time for eruption of its successor, a thick layer of alveolar bone may calcify between the permanent tooth and the gingiva. This layer may resorb only gradually, so that the successor erupts both slowly and late. On the other hand, if a deciduous tooth is extracted late enough that this alveolar barrier fails to form over the crown of the successor, the permanent tooth will usually bolt precociously toward the occlusal plane.

This effect of obstruction on the movements of erupting teeth is minimal when we consider the permanent molars of the aborigine. His jaws are typically long, and the mesial movements of his more anterior teeth provide abundant room for normal eruption of the second and third molars. The latter teeth also tend to appear early. Barrett found, from studies of serial dental casts of living aboriginal children in a settlement in the Northern Territory, that relatively often the permanent second molars appear before all the deciduous molars have been exfoliated. Only a minority of American children in a sample from central Ohio showed this sequence.[20]

My observations on skeletal material of aborigines show that the third molars reach the occlusal plane early relative to the obliteration of the sphenooccipital synchondrosis. This osseous union takes place at a mean age of 18 years in young American soldiers.[34]

The extinct aborigines of Tasmania, on the other hand, usually had shorter jaws and a less abrasive diet than those on the Australian mainland. Despite moderate attrition and some mesial movement of the anterior teeth, room for the third molars was not always sufficient to prevent some eruptive abnormalities and even impactions of these teeth, according to Steadman.[46]

The Australian aborigine has a far broader mandibular ramus than is usually seen in civilized persons, and perhaps this fact is related to the mesial

location of his posterior molars as a result of attrition. Björk[8] has published a cephalometric study of facial growth in five children in whom metallic implants were introduced into the maxilla and mandible. The Australian orthodontist, F. S. Seward, and I have slightly revised some of Björk's mandibular profiles on the tracings of the implants and found that the anterior aspect of the ramus resorbed only intermittently. This bone was lost only when the crown of a molar tooth was calcifying in the alveolar bone immediately lingual to it. We suspect that when the tooth calcifies in a more mesial position, as in the aborigine, this resorption may be suppressed. Such a mechanism might produce a wide ramus in a primitive mandible, and a narrow one in a jaw with minimal attrition of the teeth and a distal position of the calcifying molars. A cephalometric test of this conjecture could be made in civilized children who had undergone early extraction of first permanent molars as opposed to those who had not.

Dr. Fanning has shown that, even in civilized adolescents, the third molars tend to appear early if space for them is available and obstruction is presumably minimal. She has examined the mouths of thousands of high school and college students in Boston to determine when the third molar first pierces the gingival mucosa. This population has so much carious involvement that a majority had had some permanent teeth extracted, particularly the first molars. The extraction of these teeth is often followed by a closure of the resulting gap by the mesial movement of neighboring teeth, so that the perimeter of the dental arch is decreased much as it is by such movements of all the functional teeth due to wear in the aborigine.

Dr. Fanning found no sex difference in the time at which the maxillary third molar pierced the gingiva or in the variability of occurrence of this event. In adolescents with complete anterior dentitions, the median age at which this initial third molar appeared was 20.5 years. When at least one extraction had previously been performed, this age was only 19.2 years and the effect was almost identical in boys and girls. In the mandible, a still greater effect of extraction was observed.

Continuing the argument on the effects that obstruction has on how far teeth move through alveolar bone, I propose that where sufficient stresses of mastication are applied to the entire dentition, the eruptive trajectories of all teeth are vertically foreshortened.

Keith[30] and Brash[10] have made some observations on the facial architecture of primitive and civilized man which seem highly pertinent to this argument. In general, the faces of both Australian aborigines and early uncivilized Europeans tend to be rather low. The alveolar processes of the maxilla are located high in relation to the floor of the nose, so that the palate is low and broad. The nasal aperture is broad, with a fairly horizontal inferior border. The zygomatic bone (and, indeed, the whole zygomatic arch) is situated high in relation to the floor of the orbit.

These phenomena suggest to me that vertical growth in the upper sutures of the face is less intense in primitive man than in civilized persons.

Very significantly, the primitive palate is so low that the apices of the roots of the maxillary teeth are not far below the floor of the nose. In other words,

these teeth erupted a minimal vertical distance to come into occlusion. Nevertheless, this eruption continues in maturity as attrition progresses. Some older aborigines chew on caps of secondary dentine halfway down the roots of their molars, and these teeth at last are exfoliated, like the molars of a very old horse. Murphy[40] has elegantly proved that this eruptive movement persists throughout the life of the aboriginal tooth.

Conversely, in modern civilized man perhaps the slight pressures of mastication permit a maximum of vertical growth of the upper facial sutures and a greater vertical movement of the erupting teeth through the alveolar bone in childhood. Since alveolar bone in general calcifies alongside the roots of teeth, its vertical growth also is exaggerated. In other words, the civilized palate has a high arch, with high alveolar processes forming its boundaries. Some elevation may even occur in the alveolar process of the mandible. This release of masticatory pressure is apparently most extreme in the anterior teeth, so that the increase in vertical eruptive distance is usually more evident here than in the molar region. Seen in profile, in extreme cases this situation may produce a gaping angle anteriorly between the Frankfort plane and the inferior border of the mandible.

As stated previously, obstruction of the eruptive pathway probably does not alter the final volume of the calcifying roots. To my knowledge, these roots have not elongated in civilized man. Instead, the longer vertical path of eruption of his maxillary teeth brings the apices of their roots lower than the floor of the nose.

Some of the preceding facial and dental differences between primitive and civilized men have been reproduced in experimental animals, particularly by Watt and Williams.[50] These authors matched two groups of weanling rats by weight, with thirty animals in each group. Both groups ate calorically matched diets for four months. One group ate cubes of hard, crunchy Master Fox Breeding Cubes. The other consumed these cubes pulverized in water as a gruel. A similar experiment was also performed on nineteen young adult animals on the hard diet and nineteen on the gruel. Prior to the experiment these rats had been fed the hard diet.

At sacrifice, the younger, actively growing group on the hard diet showed more attrition of the teeth than did the series fed on gruel. More alveolar bone had enveloped the mandibular molar region, and the mandible weighed more. Only posterior to the molars, in the region of the ramus, was the surface area of the mandible in profile significantly increased. The condylar portion of the ramus was more mineralized. Relative to the inferior border of the mandible, the vertical eruption of the anterior molars was less marked in the rats on the hard diet. The two groups did not differ, however, in the ratio of mass to volume (density) of the mandible.

In the maxilla, the width of the dental arch between the buccal portions of the first molars was significantly greater in the rats on a hard diet.

These trends were similar in the adult rats, except that the anterior molars were not significantly elevated above the inferior border of the mandible and

the maxillary arch was not widened. This first finding suggests that "over-eruption" as a result of decreasing stress is less likely in mature teeth than in younger ones. The failure of widening of the maxillary arch seems to have occurred because the median palatine suture in the rat fused so early that transverse growth here was impossible in an adult animal.

As in the younger rats on the gruel diet, narrowing of the maxillary dental arch has often been observed in human groups as they have become more civilized. Again by analogy with this experiment, we should ascertain whether inhibition of transverse growth at the median palatine suture is an important reason for this situation.

Unfortunately, traditional anthropometry will not yield unambiguous, or parsimonious, measurements of how much bone the median palatine suture contributes to the widening of the maxillary arch as a whole. This drawback of routine caliper measurements has few exceptions in the body as a whole.[3, 27, 28]

In Australia, I attempted some crude estimates of the activity of the median palatine suture by measuring the skulls of nineteen aboriginal children 2 years of age or older, as compared to fifteen adult male and fifteen adult female specimens. The skulls were all from burial sites in a small local region in the drainage of the Murray River in the southeastern part of the country.

The measurements included the maximum breadth of the piriform aperture (nose breadth), the minimum breadth between the greater palatine foramina, and the maximal breadth of the dental arch at the buccal surfaces of the deciduous maxillary second molars or their successors, the permanent second premolars.

The nasal measurement might yield an incorrect estimate of sutural activity if bone were added or resorbed during growth at the margin of the piriform aperture. The breadth across the palate might be biased if the foramina move through the bone during growth. Several other foramina in the mammalian skeleton have been shown to move in this manner.[6] Finally, transverse displacement of the cheek teeth in growing alveolar bone is another possible source of error.

Nevertheless, all three of these measurements agree in showing an average increase of 7 mm. from about 2 years to maturity, averaging the two sexes.

Comparative evidence on American Caucasian children is available from serial dental casts originating from Boston and Philadelphia, and published by Moorrees.[35] Moorrees measured between cusps of cheek teeth, so that tipping and rotation of teeth slightly detract from the comparability of his evidence with the present measurements of aborigines. In none of his measurements, however, was the average increase more than 5 mm., and at the second premolar or its deciduous predecessor the widening was only 2 mm. from 3 to 18 years of age.

We may conclude, therefore, that the lower face widens somewhat more in aborigines than in ourselves. If the preceding evidence approximately indicates growth at the median palatine suture, it seems that this suture is less active in producing the narrow and often crowded maxillary arches of civilized children

than in contributing to the broad arches of aborigines. Furthermore, the degree of this sutural response appears to be graded according to the amount of masticatory stress within the facial skeleton during childhood.

The differences in facial structure between rats on hard and soft diets are essentially those which recur in human groups of similar genetic origins on hard and soft foods and which, to a considerable extent, separate the Europeans of the terminal Pleistocene epoch from those of today.

In summary, then, the evidences of reduced masticatory stresses in modern Europeans are narrow ascending rami of the mandible, gracility of the gonial region of the mandibular body, high and narrow dental arches, and excessive vertical eruptive movements of the teeth—especially in the anterior segment of the arches. The upper sutures of the face putatively respond to feeble mastication by growing too much, while the median palatine suture grows too little.

It is possible that, from conception onward, malnutrition also contributes to these deformities. The syndrome which Price[45] calls the degeneration of the face due to faulty foods can occur in a single generation, regardless of the racial origin or previous primitiveness of culture of the affected population. It is, nevertheless, interesting how similar Price's evidence is to Watt and Williams' findings on rats in an experimental situation in which nutritional differences were eliminated as completely as possible.[50]

Despite the impressive differences between ancient and modern European faces, and between the aboriginal face and our own, a real question remains of how great the *genetic* change in this region has been in the last several thousand years, particularly in Caucasians.

GENESIS OF FACIAL AND DENTAL REDUCTION

All through the Pleistocene epoch the protohuman dentition seems to have become smaller, along with a reduction in the anterior projection of the muzzle. It would be highly desirable to measure this trend along the lines of Kurtén's[32] investigations, because it may have proceeded more rapidly than the concomitant increase in brain size, especially in the molar region. By the end of the Pleistocene, however, Upper Paleolithic Europeans had evolved dentitions within the range of sizes seen in modern Caucasians, but their average size seems to have been slightly larger.[31] We may ask whether shrinkage of certain teeth today is a wholly genetic trend.

It is significant that the crowns of the earliest permanent teeth to erupt are already well along in the calcification process before an infant can make much headway in chewing solid food. In at least the first molars, therefore, loss of cusps as a direct result of crowding or of feeble chewing is doubtful. On the other hand, the first molar seems to be one which has changed little since the Pleistocene.

Conceivably, however, some of the permanent teeth in which calcification begins later on could be developmentally inhibited in the crowded jaws of older civilized children. Such a condition may perhaps apply to the second molar, and even more to the third. Trends over a generation or two in primitive people who are rapidly adopting a civilized diet might clarify this possibility.

Positive evidence of more frequent missing, small, or structurally simplified teeth in younger persons would suggest to me that rapid *genetic* trends toward dental reduction are not present in modern man.

Since the early Pleistocene epoch, the third molar in particular has become reduced in man. An Upper Paleolithic female skeleton from Cap Blanc, France, moreover, has a proven absence of one mandibular third molar.[18] The continuation of this trend in Caucasians is contradictory, as it shows up in one study of English maxillae but not in another of German mandibles.

Keith[30] chose twenty-five male and twenty-five female English skulls from the pre-Norman period (equal numbers from cemeteries of the eighteenth and nineteenth centuries) and twenty-five skulls of English soldiers who died in World War I. He showed that agenesis and failure to erupt seem to have increased in English third molars in the last millennium. On the other hand, Glöckner and Grimm[21] studied mandibles from Germany dating from the Neolithic period to the medieval period and casts and radiographs of the jaws of Breslaw students in late adolescence. No significant increase in congenital absence of the third molars appeared. These authors also thought that later Germans had acquired larger third molars relative to the second molars. This trend could be nongenetic, however, if the earlier Germans had suffered more attrition of the second molars than did the later persons in this sample.

In summary, then, the genetic evidence of dental reduction in Caucasians since the Pleistocene epoch is not yet airtight. As in the problem of malocclusion, it would be highly desirable to ascertain whether diminutive teeth in civilized populations are favored by natural selection.

TOWARD AN ETIOLOGICAL CONCEPT OF MALOCCLUSION

Even such useful works as that published by Brash, McKeag, and Scott,[11] as well as the orthodontic literature in general, provide little intellectual fodder for the outsider interested in the recent evolution of human occlusion. Nonetheless, some hints and speculations as to why occlusions go awry can be gleaned from present evidence.

In England, at least, the paleontologist would probably describe the increase in malocclusions since Anglo-Saxon times as a rapid evolutionary trend. If this trend has an appreciable genetic basis, the genetic mechanism may well be natural selection favoring facial deformities, the ill effects of human hybridization, or both.

Dr. S. S. Tan and I once analyzed a sizable battery of caliper measurements on nearly all the members of two classes of students of dental hygiene. Of these 120 young women, forty had normal occlusions, forty had malocclusions which had never been treated, and forty had malocclusions which had previously been treated. In the treated subgroup, the facial skeleton and muscles of mastication were significantly smaller than in the other two samples, and the two untreated groups did not differ from one another in these respects. Perhaps orthodontic patients collectively are farther along the evolutionary road toward muscular

and skeletal shrinkage in the facial region than are other members of the same population. An equally possible explanation is lack of exercise of the muscles of mastication and stress of the facial skeleton in such persons.

Nevertheless, malocclusion may well be a symptom rather than a single pathologic entity, so that such devices as the Angle classification do not separate distinct patterns of its etiology. This confused picture might be greatly clarified through studies of familial aggregation of occlusions along the lines developed by Morton and Chung[14, 36] for muscular dystrophies. These workers assembled a multitude of details of symptomatology in dystrophic pedigrees and sorted them first into patterns of possible familial heredity by means of a high-speed digital computer. They then applied a statistical method to these data known as multiple discriminant functions. This research yielded four different kinds of muscular dystrophy, each with a typical constellation of symptoms and probable mode of inheritance. I am confident that by such methods some inherited syndromes of malocclusion could be sorted out of the present chaos of cases and that this research would be well worth the effort.

Still another approach might be to define the basic polymorphism of occlusion in primitive man, over and above the life cycle which I have just outlined. This situation probably differs somewhat in the major human races, just as malocclusions differ in civilized American Caucasians and in Japanese. By this means, the malocclusions in civilized members of each race could be taken as something added to the primary polymorphism of the group as it would have been under primitive conditions of life.

In the Australian aborigine, this primary polymorphism of occlusion is by no means obliterated by gnawing on abrasive foods. In the rest position, retrognathism of the mandible is not rare.[7] In my experience with such skulls at maturity, attrition has been evenly distributed throughout the occlusal and incisal surfaces, so that the person had a sliding rather than a fixed occlusion and could readily bite with the incisors edge-to-edge. In examining hundreds of aboriginal craniums, however, I have yet to see conspicuous prognathism of the mandible. Clearly, then, the rank order of discrepancies of sizes of the jaws is similar to that found in Caucasians: normal is the most common, retrognathism is next, and prognathism is the most rare. I am sure, however, that these discrepancies in general are not as common in Australian aborigines as in ourselves.

Another quite frequent feature of this aboriginal polymorphism is the presence of minor displacements of teeth outside the curve of the dental arch, as well as a few rotated teeth. In children and young adults, however, one should be cautious about labeling such irregularities as gross malocclusions, since many of them disappear with attrition.

In long-established agricultural populations of mankind, anthropologists recognize quite a few skeletal changes, of which malocclusion is only one. A huge literature exists on the rounding of the head in such human groups in many parts of the world. Nevertheless, as in Great Britain, there are known groups whose headform has changed but little in recent centuries but whose occlusions have deteriorated.

Coon[15] and others have described an increasing fragility of the skeleton in Causasian peoples since the Upper Paleolithic period. In infancy, such a situation might prolong the plasticity of the skull and allow any appreciable occipital pressure to produce a round head for life. Possibly malocclusion is another manifestation of this trend. On the other hand, evidences of more osteogenesis and also of narrowing of the head have been revealed in a single generation among fathers and sons attending Harvard College.[9, 27] Therefore, we should not hastily conclude that the skeletal fragility of modern Caucasian populations has a wholly genetic basis. Furthermore, it would be valuable to see whether civilized populations show better occlusions as their health and diets improve.

The Congenital Malformations Survey of the National Institutes of Health is fostering a very intensive study of American pregnant women to ascertain circumstances of gestation which predispose toward congenital malformations in their progeny. Malocclusion may well be the most common of American deformities, and it is eminently worthy of inclusion in this survey. Orthodontists now have a magnificent opportunity to study occlusions in the next several years in children whose mothers have been enrolled in this nation-wide investigation. I am confident that such an investment in orthodontic research would yield far more information of general biologic interest than is likely to come from the solitude of orthodontic practice or through the isolated measurement of dental casts or cephalometric radiographs. Indeed, such geometric exercises are now near the point of diminishing returns. At this stage, we could do no better than to see and investigate malocclusion in a broader biologic context than most of us do now.

SUMMARY

Many civilized human groups have developed more severe malocclusions than they had experienced under primitive conditions of life. To the evolutionist, this change would seem rapid as compared with known rates of osseous and dental change in other mammals. He might ask whether natural selection favors malocclusion in civilized man and whether the present polymorphism of human occlusion is now reaching a stable genetic equilibrium. He might even wonder whether human hybridization under civilized systems of mating might have adverse effects on occlusion.

Apart from such possible genetic trends, it is useful to define the environmental conditions under which the human face has evolved, especially by comparing facial growth in primitive and civilized children. Part of the story, at least, seems to involve differences in the use of the jaws and in attrition of the teeth.

Where the aborigines of Australia live today under primitive conditions, their diet is tough and abrasive. In the aboriginal children the upper sutures of the face probably contribute less to the downward growth of the face than in civilized Caucasian children, and the eruptive distances traversed by their teeth are shorter, especially in the incisor region. The median palatine suture, however, seems to be more active, so that the maxillary dental arch is typically broad and low. These features also characterized the white population of Europe in the late Pleistocene period.

The aboriginal child shows two cycles of occlusal change—one for the deciduous teeth and another for the permanent dentition. In infancy, overbite of the incisors and neutroclusion of the deciduous molars are transitory. By the age of 5 years, some children have experienced so much mesial movement and attrition that the incisors bite edge-to-edge.

Now the permanent first molars and incisors erupt, and the overbite is temporarily regained. By maturity, however, the aborigine may already be well on his way toward a second edge-to-edge occlusion of the incisors. Attrition in the dental arches is usually so marked that crowding of the teeth is only a transient phase when new anterior teeth are erupting.

In civilized children, resorption of the anterior aspect of the mandibular ramus seems to be discontinuous and coincides with the calcification of the crown of the most posterior molar tooth. Perhaps this dental stage is traversed in a more mesial position in the primitive mandible and with less resorption. Accordingly, the primitive mandible at maturity has a broader ramus than is seen in most civilized persons. These conditions may also prevent late eruption and impaction of the third molar.

Evidence on how much the dentition of civilized man has become shrunken in size and on whether agenesis of the third molar is increasing is somewhat conflicting. It appears that orthodontic patients in particular show reduced facial musculature and skeletal development, but no meaningful separation of genetic entities among the types of malocclusion is yet possible. Malocclusions in civilized peoples should be thought of as complications over and above the basic polymorphism of occlusion in primitive man. The relationship of malocclusion to other skeletal changes in civilized populations is obscure. Since occlusal deformities are among the most common malformations of civilized man, the whole battery of techniques now used in research on other human deformities, especially prior to birth, should now be extended toward resolving the mysteries of malocclusion.

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DIAGNOSIS AND MANAGEMENT OF ANKYLOGLOSSIA

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THE perverted use of the tongue is a very prevalent factor in certain types of malocclusion. Sometimes this perversion is the result of a habit acquired early in life. For example, prolonged artificial nursing with a nipple which is too large for the infant's mouth may lead to abnormal tongue posture, and prolonged thumb-sucking may cause the patient to use the anterior portion of the tongue in swallowing instead of raising the dorsum as in the normal swallowing pattern.

Speech defects are often associated with abnormal swallowing. The most common is the production of the "S" sound off the incisal edge of the lower incisors instead of behind the incisive papilla. This gives a compromise "S" sound. Then, too, there is the out-and-out lisp which is caused by allowing the tip of the tongue to touch the maxillary incisors in making the "S" sound. There is another unusual condition which, for want of a better word, we call a "lateral lisp." Here the air and saliva are forced off the side and edges of the tongue instead of off the tip. Other sounds influenced by abnormal tongue position are "T," "D," "L," and "N."

Abnormal anatomy is another factor which influences tongue function. Often the tongue is tied down by an abnormally tight lingual frenulum which may be fibrous or muscular. The tie may be complete or partial. In some patients fibers of the genioglossus muscle are too short or they are attached in such a way that the tongue is held too low in the mouth, giving the appearance of macroglossia. This condition is present in many Class II, Division 1 cases and in nearly all Class III cases. In many instances the upper arch is underdeveloped and the lower arch is overdeveloped because of the abnormally low position of the tongue. If the tongue is held a little higher in the mouth, a lateral tongue-thrust may be present, thus causing an open-bite in the bucal segments on one or both sides. Quite often this condition is present in patients who appear to have Class II, Division 2 malocclusions. In these patients the characteristic rest position is one in which the tongue spreads out laterally and the mandibular dentition rests on the sides of the tongue in such a way that the pressure of the tongue is upward against the maxillary bucal teeth and

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downward against the mandibular buccal teeth. This prevents these teeth from erupting to their full occlusal height. The teeth are rarely brought into occlusion, but when they are occluded the appearance is that of a deep overbite case.

If the tongue is held somewhat higher and protuded, as it is in many Class II, Division 1 cases, there is an anterior open-bite. This also may occur in Class I cases. Some Class II, Division 1 cases are potentially open-bite cases, but this is not recognized until after appliance therapy has been instituted. It is well to observe the occlusal plane of the mandibular teeth. If it is perfectly flat and there is a space between the incisal edge of the mandibular incisors and the palatal surface of the maxilla, the patient probably has a tongue-thrust which is camouflaged by the protrusion of the upper incisor teeth. In a Class II, Division 1 case in which the mandibular incisors are close to the palatal surface, or even bite into it, there usually is no tongue-thrust. During the diagnostic examination the patient should be told to swallow. The lower lip is then pulled down during the act of swallowing and the tongue will be seen protruding between the teeth, either anteriorly or laterally. If the tongue is very low in the mouth, it will be observed that the greatest amount of tongue pressure is being exerted against the lower teeth with none at all against the upper teeth. If this condition is the result of abnormal muscle use, it can be corrected by training. If it is the result of an anatomic abnormality, correction calls for surgical intervention followed by tongue training. The muscles of the tongue are as readily trainable as muscles of any other part of the body. Anyone who has ever taken piano lessons, or lessons on any musical instrument, knows that at first there is great difficulty in moving the fingers rapidly or properly. With practice (which is really muscle training), it becomes possible to move them without even thinking. Many of us can throw or bat a ball. These actions also are possible because of muscle training. An athlete of any kind is not necessarily a heavily muscled person. Rather, he is a person who has trained his muscles to function in an efficient pattern.

Regardless of the type of tongue perversion, the training procedure is the same.

TONGUE TRAINING

When tongue training is instituted, it is done without any explanation to the patient. First, the midline of the hard palate is pressed with a blunt instrument, about in line with the distal surface of the first permanent molars. This pressure should be just firm enough for the patient to recall the site of application of the instrument but *not hard enough to hurt him.* Next, we take a small piece of sugarless mint which has been broken into very small irregular pieces. One of these irregular pieces is placed on the dorsum of the tongue, and its location is determined by touching the tongue lightly. The anterior third of the tongue forms a hollow, and the mint is placed on the midline of the distal border of this hollow. On the first several tries the candy usually rolls down into the hollow; however, the candy is replaced and the patient

is instructed to close his teeth together. Then he is told to hold the candy on the spot in the roof of the mouth which was previously touched. He will make an effort to do this, but he probably will not succeed the first time or two. The location of the candy is checked each time, and the originally pressed spot on the roof of the mouth is touched again at each try. The patient is asked to close his teeth and try again. Suddenly he will find the proper position and the tongue will no longer protrude between or press against the teeth. At this point the patient is given a mirror to see for himself where his tongue is when it is in the correct position. The patient is asked to repeat the exercise several times to be sure the candy is in the proper position. This exercise is to be done *constantly* for the next three or four days. The reason for doing it constantly is that one swallows during all of his waking hours. A little training now and then will do absolutely no good. If the situation is explained beforehand and then the patient is instructed, he will usually curl the tip of the tongue upward. ***The goal is to teach him to raise the dorsum of the tongue, which he has never done before.***

At first the patient may complain that the muscles in the submental and sublingual regions are tired. This possibility is carefully explained to him. In a few days this tiring will disappear. The patient is checked in about a week to make sure he is following the instructions as given. If he is not, he is re-instructed and his interest is revitalized. Appliances should never be placed in the mouths of these patients until the tongue is functioning correctly. The reason is that the minute an appliance is placed, the patient feels that it will correct the malocclusion. It is imperative to explain to the patient that an appliance will not be placed until he has trained his tongue to function properly.

After swallowing has been corrected, we then proceed to correction of the speech habit. If the patient has a swallowing perversion, he often has a speech defect. As mentioned before, if he sounds his "S" off the incisal edge of the lower teeth the speech defect is often so slight that it is not very noticeable. If the tip of the tongue touches the maxillary incisors during formation of the "S" sound, there will be a distinct lisp. We cannot go into the details of speech-training procedures in this article. There are many good books and papers which cover this subject. In any event, we must make sure that the patient is sounding his "S" by placing the tip of his tongue just behind the incisive papilla.

GENIOGLOSSOTOMY

When the perverted use of the tongue is the result of an abnormal lingual frenulum, it is necessary that this frenulum be resected. One should keep in mind the fact that a fibrous frenulum can be attached quite far anteriorly and still not impair the function of the tongue. Visual examination is not sufficient for a diagnosis. If we run our fingers below the tongue and try to raise it, we can feel the resistance from the tongue musculature, mainly the genioglossus muscle. The patient is then asked to elevate the tongue. In most instances he can raise the tip readily, but the observer will note that the tip

comes straight up while the dorsum remains flat; in fact, there is a dimpling in the dorsal area which corresponds to the insertion of the restraining genioglossus muscle.

The surgical correction of the ankylosed genioglossus muscle may be performed under either local or general anesthesia. If a general anesthetic is used,

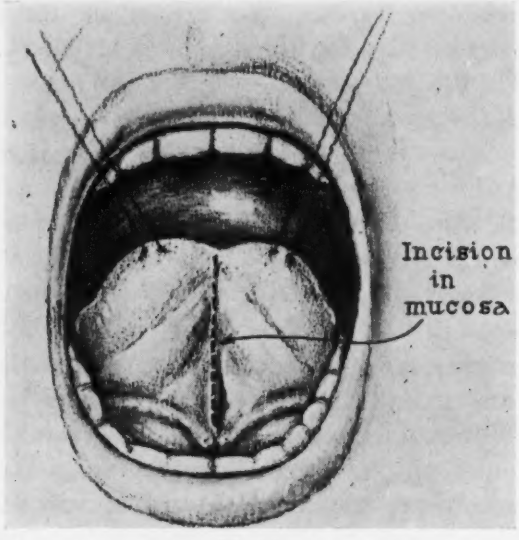

Fig. 1.

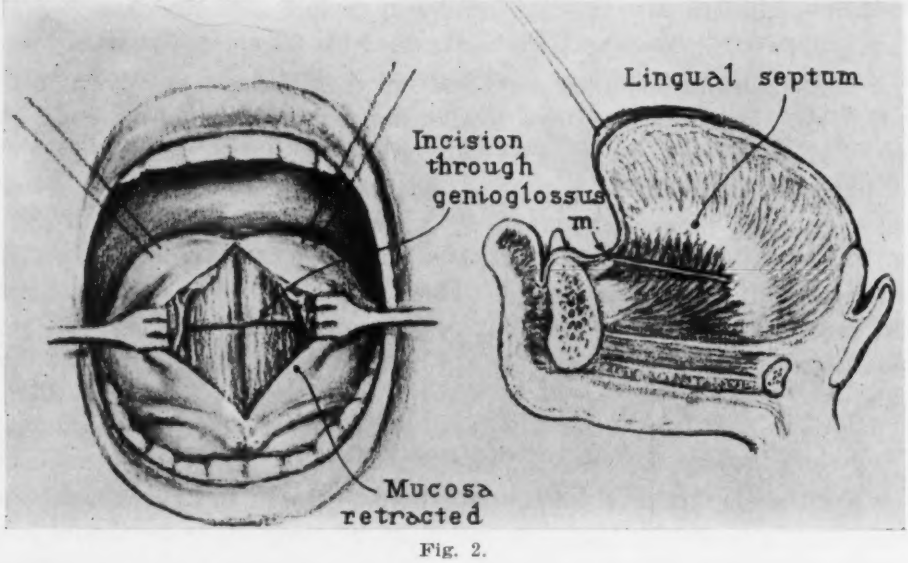

Fig. 2.

then it should be administered via the nasoendotracheal route. As shown in Fig. 1, the tongue is retracted superiorly, and two silk sutures are placed through each side of the tip of the tongue. A vertical incision is then made through the mucosa along side of the frenulum, from beneath the tip of the tongue to just in front of the orifices of the submaxillary ducts. Fig. 2 shows the retraction of the mucosa and the transection of the genioglossus muscles. It is

essential that this transection be performed down to the lingual septum, which is an anatomic fibrous band separating the bulk of the dorsal intrinsic muscles of the tongue and the insertion of the superior fan of genioglossus muscles. This septum may be identified as a *white line*. At this site, the transection of

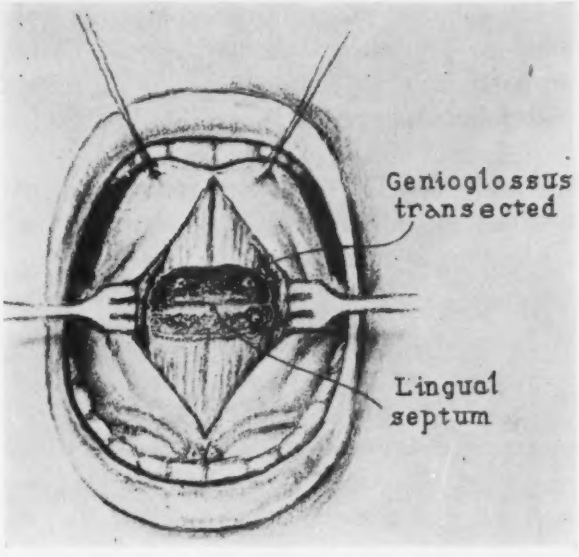

Fig. 3.

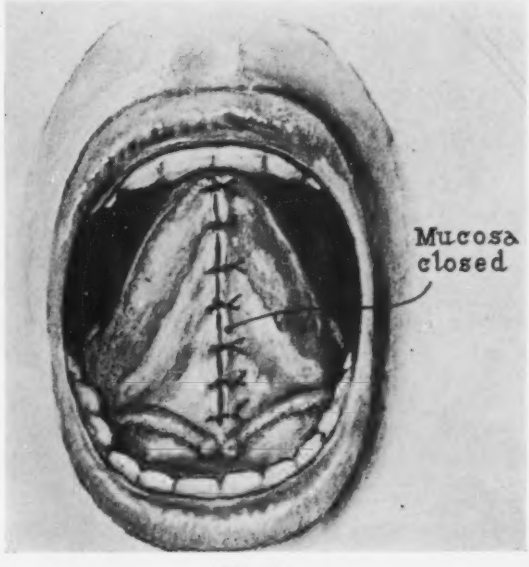

Fig. 4.

the genioglossus muscle is completed, and full retraction of these muscles follows (Fig. 3). Except for the occasional small vessels, no further suturing is done in the transected muscle. Its ends are permitted to retract freely. The tongue itself is now readily elevated. Closure, which is limited to the mucosa, is accomplished with a series of interrupted fine chromic catgut sutures (Fig. 4). No drainage of the wound is necessary.

Postoperative care is generally minimal, but the patient may require simple analgesics for pain. Clear fluids may be permitted following complete recovery from the general anesthetic. No limitations are given regarding motion of the tongue. In fact, tongue motion is encouraged, so as to limit apposition of the transected muscles. If the patient keeps the tongue moving, it is amazing how little soreness or postoperative discomfort he experiences. About one week later tongue training as previously described should be instituted, since the genioglossotomy, in itself, will not cause the tongue to function properly. The patient must be retrained; otherwise, he will follow the original pattern of malfunction.

Many open-bite and Class III conditions relapse when treated with appliances only. If the cause of the condition is removed first, a more stable result following appliance therapy is encouraged.

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RESEARCH AND THE PRACTICING ORTHODONTIST

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INTRODUCTION

THERE can be no more than a small number of persons who need to be convinced of the tremendous importance of scientific research in our present-day civilization. The term "research" has become a significant word in our vocabulary. It is true that the advent of the nuclear era has stimulated this respect for research, but, as often happens, the by-products of the original development exceed the product itself in importance. In this case the by-products are manyfold and extend into all branches of scientific endeavor. To be sure, scientific research is not a new development. However, its acceptance by our present-day society will do much to promote it at a more rapid rate. On this basis, therefore, it seems that a review of the research process and its relation to the practicing orthodontist might strengthen in some measure an awareness of this all-important scientific activity.

The history of scientific research[1] dates back to the time of Babylon. By the simple process of observation, the Babylonians were able to further develop the field of mathematics. This development included formulation of the decimal systems as well as a further refinement of the multiplication tables. In Egypt the process of observation produced an elementary standardization of techniques for the study of anatomy and the performance of certain types of surgery. Progress in this respect, however, was definitely limited because of the fact that progress based on observation alone did not lend itself readily to creative thinking.

During this period of history man had not yet become acquainted with the process of hypothesis, but this was primarily because of the deep-rooted religious influences prevalent at that time. All scientific observations were interpreted on the basis of religion and mythology and tended to undermine rather than advance scientific reasoning. Freedman[1] explains that such a faulty approach in reasoning can lead to an indefinite number of interpretations, all of which are equally convincing to their followers and supporters and none of which are capable of experimental confirmation.

Based on a paper read before the 1958 Meeting of The Great Lakes Society of Orthodontists in Columbus, Ohio.

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The quality of this early type of interpretation of observations led not only to the stagnation of science but to its deterioration. Such deterioration led to the countenancing in medicine of various charms which, through their religious implications, were meant to cure the person of all diseases. It is interesting to note that this faulty approach still passed for good scientific reasoning even in the eighteenth and nineteenth centuries.

The process of hypothesizing did not formally make its appearance until the beginning of the sixth century B.C., when Greek scientists added hypothetic reasoning to the observations that they were making. Ionian philosophers, by their interpretation of the universe and its origin, established the scientific hypothesis as an integral and essential part of scientific investigation.

Freedman credits Pythagoras and his disciples with the next and possibly the most important advancement in the history of scientific research. Pythagoras developed the quantitative content of the hypothesis and then went on to develop the third and fourth steps of scientific research—experimentation and induction.

Society at that time also had a marked influence on the development of science and on scientific research, as is well illustrated by a study of ancient Greek history. Freedman explains it as follows:

> The economy of ancient Greece was based on slavery; and while it gave Greek gentlemen the leisure and material security which enabled them to combine intellectual power with a desire for knowledge and to engage in contemplation and reasoning, it made them despise the effort and skill of a man's hands. Such a feeling became a great hinderance to experimentation and made development of sciences . . . which utilized a man's skills of dexterity, completely impossible. Physics failed to develop also except in the sphere of acoustics which was connected with music and therefore not contemptible.
>
> Knowledge was prized but the acquisition of new knowledge through scientific research was rejected in favor of acquisition of new knowledge through philosophic discussion. The great intellectual figures in Greece after Pythagoras . . . namely Socrates, Plato, and Aristotle were not experimentalists but philosophers. Socrates thought that philosophy should not concern itself with natural science but with ethics. Plato condemned experimentation either as contemptible or irreligious. Plato's attitude was antagonistic to scientific research and, because he was a great man, the harm he did to scientific research was grievous and long enduring.

Aristotle, it seems, tended to be a scientist in addition to being a philosopher and, as a result, his influence was more favorable. Freedman points out that Aristotle's influence on scientific research should be closely studied, as it leads to a number of important conclusions:

> 1. It is possible for a man to possess the highest intellectual powers and the greatest scientific learning without possessing the corresponding gift to discover new knowledge and understanding.
>
> 2. That a man with little scientific knowledge may make scientific discoveries which may not be appreciated by a learned authority.
>
> 3. That in scientific research whose very nature consists in discovering that which is not yet known, authority must be a modest guide and not a judge from whom there is no appeal.

RESEARCH METHODS

Research may be divided into two general categories: *basic research* and *clinical research.* Irrespective of whether the interests of the investigator are basic in the sense of fundamental knowledge or whether they are motivated toward the treatment of patients, the approaches to studying the problem are quite the same. The methods[1, 2] for attacking a research problem may be divided into four categories: (1) the check-up type of research, (2) a new method in an old field, (3) the empirical method, and (4) the new method.

1. *The Check-up Type of Research.*—This is essentially a method of repeating a previous experiment. The methods of investigation can be followed confidently, and often without any modifications whatever. This type of research is very valuable in clinical areas, as it tends to support or contradict previous findings. All clinical research is beset with many variables, and check-up research often adds to the accumulated knowledge. The human being is an individual. He has a mind, a soul, a potential for individualistic reaction. He is the poorest subject that a researcher could deal with, and thus he presents problems that in most cases can be solved only by repetitious experimentation. Research orientation with young investigators often begins in this area and often proves a fruitful stimulus for future research. In short, this is a good method for beginning researchers.

2. *A New Method in an Old Field.*—This is essentially a type of research that applies new methods and equipment to an old problem. It is one of our most important types of activity, since it tends to give support to old findings and concepts and often calls our attention to concepts and dogmas that are not valid. In clinical activity, this type of research is again essential. Too often, treatment of a patient is dependent upon previously reported research. It is imperative that these findings be confirmed by the newest and most readily available methods and equipment at hand. In a sense, it is related to check-up research in that repetition is necessary, the fundamental difference being that more critical methods and equipment are utilized. Many concepts of diagnosis that prevailed before the advent of roentgenology are no longer remembered; this is the result of more critical findings based on the use of a new tool. It would be hard to deny the impact on orthodontic treatment made by the findings of Down's analysis, findings made when an old problem was attacked by a new method and with new equipment.

3. *The Empirical Method.*—This type of research offers the researcher a certain amount of excitement, since a forecast of results can be made but possible alternatives are always inherent. It is further flavored with the necessity of devising new techniques and developing new apparatus in order to make the investigation possible. In most cases, this type of research is more successful when attempted by experienced researchers who have learned the many disciplines necessary for this activity. A particular piece

of research of this type may often be of value, even if the result is negative, and the conclusions may suggest how the problem could be attacked in a different manner.

4. *The New Method.*—This has been characterized as the least dramatic type of research, and yet it has often proved the most fruitful. Examples of this kind of activity will better illustrate the method. The discovery of the electron microscope was not hailed as any great achievement, and yet the utilization of this equipment has made possible countless contributions to man's welfare. Likewise, the discovery of the Bolton cephalometer or the radiographic laminograph attracted little attention, but the results of research utilizing this equipment are known and respected. It is obvious, then, that this type of research opens the way for thousands of investigators to pursue research problems. It is, therefore, indispensable to our research interests.

THE RESEARCH PROCESS

The question of how we can best implement the foregoing types of research activity brings us to the research process and the disciplines to which one must adhere in order to conserve energy and time and thus bring to fruition, in the most efficient manner possible, the results of his efforts. This discipline is imperative to the investigator, especially if he realizes that at best the research endeavor is often an inefficient activity and that a planned attack is necessary to cope with the problem.

The several phases of the research process itself may be considered in the following sequence[3]:

1. *Prior knowledge or opinions.* These opinions are ideas that are acceptable to the majority. This concensus of opinion can often be determined by reviewing the literature, although certain precautions at times became necessary. Majority opinion must not be accepted as fact in every case, but those opinions that have stood the test of time and reinvestigations are usually acceptable. The steps in G. V. Black's cavity preparations are relatively good examples of this point; Black's conclusions are generally accepted as classic.

2. *Logical deduction.* This process of thinking helps one develop a sequence of ideas that may possibly lead to a new concept or a new fact. Many reports in the literature are of the basic information type and may be synthesized into a concept applicable to clinical treatment. Validity of the concept, however, can be ascertained only by actual application to treatment and by proper documentation and evaluation of the results.

3. *Formulation of the hypothesis.* Many consider this the most important phase of the research process. It may be well to add that it is also one of the most difficult. Actually, the hypothesis is the investigator's prediction. It is the concept that he is attempting

to prove, the objective toward which he is laboring. Many new investigators mistakenly believe that a hypothesis based on logical deduction is the end; actually, it is only the beginning. Proof by experimentation must necessarily follow.

4. *Experimentation.* This is the actual and physical part of the research process. Experimentation means testing the hypothesis, and it necessarily taxes the powers of methodology and materials. Experimentation tests the effectiveness of the hypothesis by determining its capability of being accepted or rejected. In a true sense, one never proves or disproves a concept by experimentation. One can only show whether or not findings are consistent with the hypothesis.

5. *Evaluation and interpretation of data.* First, it is essential that these data be usable and, imperatively, reproducible. Data that no one else can reproduce are invalid. This should always stand as a primary objective in all experimentation.

6. *Conclusions.* At this point in the research process, a determination must be made. Is the hypothesis proved or disproved? Is it acceptable? Or is it to be rejected? Are the data too inconclusive to permit one to base a decision on them? Or are there sufficient data on which a new hypothesis may be formulated?

In a sense, the research process sounds formidable; yet, it is actually fundamental. Above all, it is essential, and most essential is the recognition of fundamental approaches. Research can be done only if the rules are followed, and any violation invites confusion and error. Facts are facts, and fortunately true researchers are the first to recognize the problems that tend to reflect credit or discredit on their cherished activity. One significant problem is that an appreciable portion of the literature today is of little value. This is indeed unfortunate, but more tragic is the fact that it is often misleading. It would behoove everyone to evaluate carefully the messages that often are circulated for general consumption and assimilation. Parrotlike reproduction of literary claims is a common error that many of our researchers make in their writing, and acceptance of such reiterations must be carefully weighed. It would be well to remember that uncertainty is always present in clinical research. Dogmatic acceptance only weakens the foundation of future progress.

For practical purposes, the research process is not complete at this point, however. Conclusions must be followed by the transmission of information, and this, of course, means publication. Here strict discipline must be honored, and only valid information must be transmitted. If publication is the primary goal of the investigator, true research is not being served. Also, routine publications often mislead others and, as a result, make the job that much harder for those who follow.

In order to evaluate the results of an investigation, some analysis of the data becomes essential. Statistical analysis is only a tool by which

certain limits of error and reliability can be ascertained. The investigator himself must decide the levels of error which he will accept. He must call upon prior knowledge and experience to help him in determining what alternative hypotheses are reasonable and what the cost will be for certain errors. The necessity of answering these questions demonstrates the fallacy of expecting a statistician who is unfamiliar with the background to analyze tables of data presented to him as an abstract problem. The statistician, however, can give invaluable advice in the planning of an experiment and may suggest methods which will be more suitable for analysis of the data. Furthermore, voluminous pages of data and charts will not salvage an experiment with a hidden bias.

Planning.—What, then, is a good approach to research? What does an experimenter have to do in planning a research project? The following suggestions[2] are basic:

1. *Write down an idea.* A short pencil is better than a long memory. Use a notebook and record your ideas and raw materials for future use.
2. *Make an accurate statement of the problem.* Much waste and frustration result from an imperfect statement of the problem that one is interested in investigating. Too often the statement is based on observations and conclusions that are faulty. Sometimes a very real problem may be trivial in its importance, and thus the research findings would not be used even if the problem were solved. A careful statement of the problem often sheds light on these factors, and frequently a little extra time spent in restating a problem in different ways, redefining it, or expressing its limits will point the way to its solution.
3. *Discuss your plans with one or more other persons.* Select a competent person whom you consider a friend. (You will more readily accept criticism and advice from a friend than you will from someone whom you judge to be antagonistic or unfriendly.) Prepare yourself to be receptive to constructive criticism and to the revelation of errors and loopholes that, in your bias and enthusiasm, you may have overlooked.

These, then, would be the preliminary efforts in the planning of a research problem. They would obviously be an expression of interests and would reflect the amount of knowledge, experience, and background necessary to attack the problem. From this point on, consultation is usually necessary for the beginning researcher. His next step is experimental design, and this requires an approach that will best suit the problem to be investigated. Briefly, experimental design is the formal plan of attack. It is the pattern and sequence that will be followed per se; this includes the conditions surrounding the problem, the procedures to be followed, and the observations to be evaluated. The methods to be followed in the experimental design must be free from

bias, since obviously biased designs will not give valid results. The problem of bias is by no means a small one, and it actually turns out to be the most serious single factor that often invalidates an otherwise fine piece of investigative work. Finally, the experimental design must be one that will produce the most efficient values or results most economically in terms of time, labor, expense, and the like. Thus, experimental situations often demand ingenuity in design if the investigator is to enhance the probability of obtaining significant data.

Experimental Data.—Observations are useless unless they can be interpreted; therefore, the analysis of such data forms a very critical stage in all research. This is the stage which has been responsible for most of the failures and fallacies of the past. In drawing conclusions from the results of experiments, it is important to use all the evidence. The investigator must guard against selecting evidence that will tend to prove his hypothesis and neglecting as extraneous evidence that would tend to create doubt. It is very easy for prejudice to enter at this point. Failures in interpretation may occur because valid relations are not recognized. Chance variations may cover up the regularities that are validly present, and chance variations may produce a pattern which deceivingly simulates a regularity. If any one of these factors succeeds in deceiving the investigator, a fallacy may result. The science of statistics has been developed for the purpose of assisting in the separation of chance effects from true regularities. Everyone engaged in research activity should, therefore, have an understanding of the basic principles of statistics.

Reporting Results.—A research project is not completed until it has been reported and, if possible, published. It is surprising how much work is carried through to completion and then left to languish in a notebook where it is not available to anyone. Publication should be prompt and complete. To a surprisingly large number of researchers, writing for publication becomes the most difficult phase of the scientific process. It is understandably time-consuming and arduous work. It is the least exciting to a person who has lived through the experimental process itself. It is like trying to live over a very enjoyable experience and not knowing just exactly how to reproduce it.

Outlines that may be followed in the writing of a scientific paper are available in most standard texts on scientific writing. In general, however, most forms acceptable for publication in dental journals follow the following style[4]:

The *title* should be descriptive and appealing. This is important if the paper is to attract all the attention it deserves. The title should conform to the *Index Medicus.*

The *introduction* should be rather short and concise, and it should include a statement of the problem. It should explain why it is a problem and suggest its importance. The purpose of the study should be stated, and in one or two sentences the answers that were found to the question should be explained. This is a slight departure from previous forms in that formerly the answer to the question was usually reserved for the discussion and conclusions.

Review of the literature. This section of the publication should explain what has been done previously in this area, and it should consider the following questions: Is what has been done acceptable? Or are there possible deficiencies? What has not been done? *Why* has it not been done? What now needs to be done, and what would be the best way to do it? A chronological or historical review is no longer considered proper. It is more acceptable to confine the review of the literature specifically to the pertinent problem and to the question that one wishes to answer.

The section on *method and materials* follows. Was the method used experimental? Or was it clinical? Were the methods new or old? Were the criteria used for evaluation observational, measurable, or statistical? The information should also include the numbers of subjects studied; the time that elapsed, as well as other similar and pertinent details; and the steps that were taken to ensure adequacy of sampling and the controls that were utilized.

Next there should be a section on *findings.* These findings should be listed in order but should not be interpreted. Graphs, tables, or photographs may be used to present the data in detail. The general text of the findings is used to summarize the details contained in the tables or graphs and not to present the detailed data. It is often desirable to illustrate the findings by presenting typical cases. Data should be regrouped into a body of meaningful information. The investigator may know what his data mean, but it is important to give them clear meaning for proper dissemination to as large a field of readers as possible. There is nothing so frustrating as charts and graphs which may be clear to the author or other critical researchers but are meaningless to the busy practicing orthodontist or the less experienced researcher. It is most important to write for one's audience. Too often journals publish articles that cannot be easily understood by the average practitioner who is not active in the research or statistical field. The aim of all such scientific research should be application, and application can be made only if research is understandable to the majority of workers in the field or specialty.

The significance of the findings is interpreted in the *discussion* section. One must distinguish clearly between a statement of fact and an interpretation of the facts. The findings of the experiment should be related to the findings in the literature. Do the findings concur? Or do they contradict? Are they in any way compatible? If possible, the results should be related to clinical application. Finally, the limitations of the study and suggested possible remedies for future studies should be reported.

The summary should be brief and should state the purpose of the investigation and the methods and materials used.

The conclusions should list the major findings. These should not be interpreted, and no discussion should be included.

Finally, there should be a *bibliography and acknowledgements.* It is important that proper credit be given for assistance from other sources. Not only does this give recognition to another author's efforts, but it also provides the reader with an invaluable source for additional study and review.

Evaluation of Literature.—Like members of any profession, the orthodontist must be a continuous student. He must never be satisfied with the limited knowledge that experience alone brings him. He must supplement this knowledge on a continuing basis, and one of the most effective ways to accomplish this is to be able to make a critical evaluation of the literature. The literature today runs into volumes and volumes of published reports and findings. It is, therefore, essential that some efficient system for the coverage of literature be devised. One way for the practitioner to keep well informed is through the use of abstract cards. A punch card system for this purpose can be obtained from various sources. A system of reading habits is essential for growth and development in any field, and the following approach for reviewing current literature may be utilized[5]:

1. The title should provide the initial interest to the reader.
2. The reputation of the writer or the laboratory from which the article originated should be checked.
3. Turn to the summary of the paper; it should state observations and conclusions.
4. Decide at this point whether or not the article interests you.
5. Then leaf through the article and check the procedures, charts, photographs, and other points that may interest you further.
6. Begin the paper at the introduction to determine the objectives and problems which the author deems important.
7. Read the discussion last.

This approach will often save much valuable time, since the procedure may be interrupted at any point with a minimal amount of risk that some valuable piece of information has gone unnoticed.

DISCUSSION

How can this research method, this scientific process, be of any value to the practicing orthodontist? I would like to submit for consideration several thoughts along this line. In some cases at least, there seems to be a basic inability to utilize the scientific literature in the individual orthodontist's clinical practice. The result is that there is a lag of a number of years between the discovery of new scientific principles and their actual use in orthodontic practice. The major dependence, then, tends to be on empirical methods and traditional dogmas. The question regarding all research findings, as far as the practicing orthodontist is concerned, should be: "Does it work in practice?" The testing of new methods of treatment in practice may be called "operational research." And many of the procedures discussed previously can be used under operational conditions to test new ideas without interfering with normal office operations. The actual scientific process is not so forbidding as it sometimes is made to sound, and statistical reasoning is not entirely a strange process to the practicing clinician. No other single specialty of

dentistry today has the rigid indoctrination in documenting the progress of treatment that characterizes orthodontics. The taking of impressions and the making of record models is practically the first thing that a future specialist in orthodontics is taught to do. This exercise is closely followed by a precise method of taking histories and careful roentgenographic records and making studies which all add up to important data for evaluation. As a result of this discipline, the orthodontist is well oriented to the field of dental research; this well may be the reason why so many research contributions not only to orthodontics but to the general field of dentistry, medicine, and even speech therapy have been made by investigators with backgrounds of orthodontic education. These contributions are still continuing, and they must be further enhanced. Complete facilities for research are not practical in a practicing orthodontist's office, but adequate facilities for documentation, such as cephalostats and carefully kept records, are standard in most orthodontic offices. The office activity can readily be supplemented by the many resources of a nearby university orthodontic department, which in most cases are available to interested practitioners who wish to engage in research. It is unfortunate that today many orthodontic departments are deficient in teaching personnel, but this shortage does provide an excellent opportunity for practicing orthodontists who would like to combine a private practice with the stimulation of a teaching and research position.

Wilson[3] reflects on scientific research as follows:

> Though the road may seem long and arduous, with many stretches of pure drudgery, when the end of a particular stage is reached, when the bits of evidence all fall together into a clear pattern, there are few other human activities which can provide as much satisfaction; especially if, as is so often the case, the results turn out later to have application in all sorts of unanticipated directions and help both to give a clearer picture of the universe we live in and to make life in that universe more worthwhile.

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ANALYSIS OF TONGUE, SOFT PALATE, AND PHARYNGEAL WALL MOVEMENT

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THE problem of measuring the radiographic images of such nebulous structures as the soft palate, tongue, and posterior pharyngeal wall may be likened to the problem of measuring a wet oyster. Like the oyster, these structures have no exact beginning, no definite end, and no outstanding points of identification.

X-ray methods of visualizing the tongue, soft palate, and posterior pharyngeal wall are much more advanced than the methods of measuring the x-ray pictures thus obtained. The soft palate, posterior pharyngeal wall, and tongue may be visualized adequately by existing x-ray techniques, which include lateral cephalometric radiology, lateral cephalometric laminagraphy, and lateral cephalometric cinefluorography. If x-ray pictures of oral and pharyngeal structures are to be comparable, the use of standard cephalometric procedures is essential. For comparable x-ray pictures of oral and pharyngeal soft-tissue structures, exact control of posture in all planes is necessary. The usual stabilization with ear rods must be supplemented with some device to prevent tipping of the head. Lateral radiographs of the head and neck are generally used. Frontal radiographic images of these soft-tissue structures are superimposed upon each other and upon the dense image of the cranial structures.

A standard and generally accepted x-ray analysis system for the measurement of oral and pharyngeal soft-tissue structures has not been developed. X-ray analysis systems designed for this purpose have been described in the literature. Some have merit, whereas others are less useful. Many of these references are not readily available. In this article I shall evaluate the various systems and propose a system of analysis based on the best meaurements found.

REVIEW OF THE LITERATURE

Early references concerning the objective measurements of soft palate, pharyngeal wall, and tongue position have been contributed by workers interested in speech function.

These lateral x-ray studies of the speech mechanism were primarily concerned with the change in position of the high or arching point of the tongue.

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Russell[20] found no characteristic tongue-arching position for each of the various vowel sounds that he studied. Parmenter and Trevinõ[17] pointed out that Russell failed to control the posture of the head during exposure of his x-ray films. Norris[16] and Holbrook and Carmody[12] agree with Parmenter and Trevinõ that there is a characteristic tongue-arching position for each of the various vowel sounds in the same person. The tongue's high point, or arching point, continues to be an important reference point for the positioning of the tongue in the oral cavity.

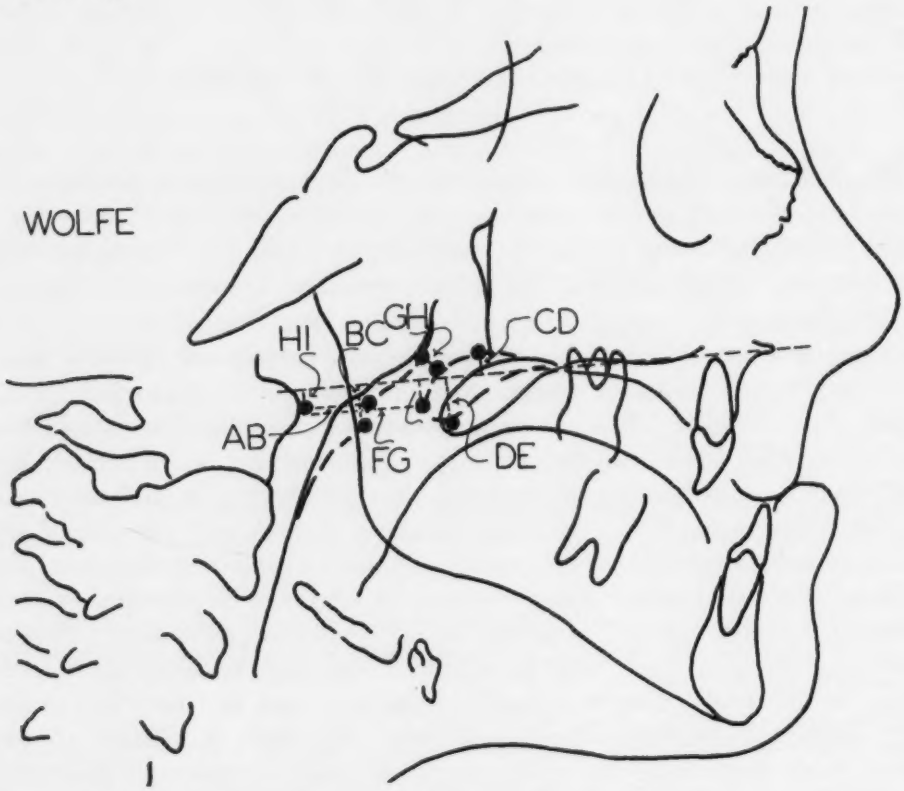

Fig. 1.—Wolfe's measurements of the velopharyngeal area.

AB = Distance from tubercle of atlas to back wall of pharynx.
BC = Distance of bulge of back wall above or below atlas.
CD = Length of velum above nasal reference line.
DE = Length of velum below nasal reference line.
EF = Over-all length of velum *(CD + DE)*.
FG = Distance from tubercle of atlas to most posterior point on velum.
GH = Shortest distance from back wall to velum.
HI = Distance of nasal reference line above or below atlas.

In 1942, Wolfe[27] presented a cephalometric x-ray study of nasopharyngeal closure during rest and during phonation of the vowels "a" and "ae." Wolfe measured movements of the soft palate and the posterior wall of the pharynx according to a system which used the palatal plane or nasal reference line as a basis. Vertical points were measured according to their position above or below the nasal reference line. Horizontal points were located by passing perpendicular lines to the nasal reference line and measuring the distance between these perpendicular lines. In Fig. 1 it may be seen that Wolfe's system gives the appearance of a grid oriented according to the inclination of the palatal plane.

In 1948 Williams[25] used cephalometric radiology to study velopharyngeal closure and tongue position during phonation of certain vowel sounds. His subjects were normal male adults. Williams chose the Frankfort plane as a basic reference line. Essentially, his measurements were similar to Wolfe's.

Hixon's[11] dissertation, written in 1949, included an extensive analysis of morphology and function of the oronasal and pharyngeal areas. Hixon measured lateral cephalometric radiographs of persons with normal and nasal speech taken during rest and phonation of various vowels. His system is essentially a

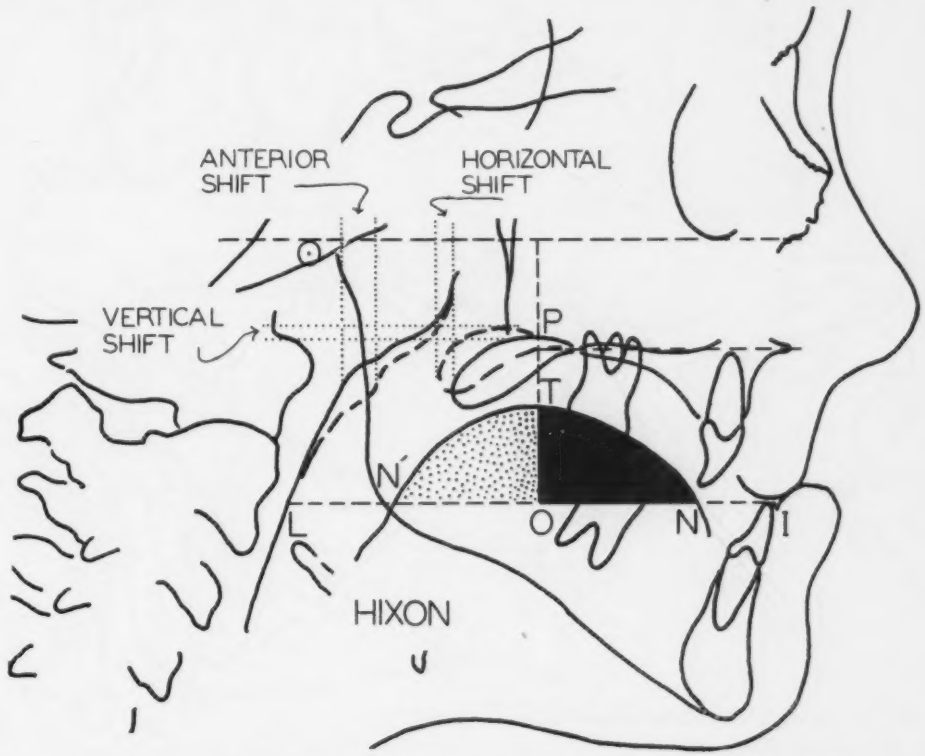

Fig. 2.—Hixon's measurement system, including some modifications by Buck.

Linear measurements of tongue:

P-T = Palate to high point of tongue.
T-O = High point of tongue to incisal reference line.
L-I = Oral cavity length on incisal reference line.
I-O = High point of tongue from lower incisor on incisal reference line.
N-N' = Tongue length on incisal reference line.

Measurement of tongue area:

N'-T-N-O = Total midsagittal area of tongue above incisal reference line.
T-N-O = Anterior sagittal area of tongue above incisal reference line.

Ratios involving measurements of tongue:

$\frac{T\text{-}N\text{-}O}{N'\text{-}T\text{-}N\text{-}O}$ = Anterior tongue area divided by total tongue area.

$\frac{I\text{-}O}{I\text{-}L}$ = High point of tongue from anterior oral cavity divided by total length of oral cavity.

Linear measurements of velopharyngeal area:

Vertical shift = Distance between a projection of Frankfort plane through high point of palate during rest and a similar projection of Frankfort plane through high point of palate during phonation.
Horizontal shift = Distance between the perpendicular to Frankfort plane drawn through posterior point of palate during rest and a similar perpendicular to Frankfort plane drawn through posterior point of velum during phonation.
Anterior shift = Distance between posterior pharyngeal wall during rest and during phonation of vowel sound as measured along a projection of Frankfort plane passing through anterior tubercle of atlas.

grid based on the Frankfort plane (Fig. 2). All basic lines were measured along parallels and perpendiculars of the Frankfort plane. Among the more interesting and most commonly mentioned measurements used by Hixon are those based on what he calls the incisal reference line. This reference line is parallel to the Frankfort plane and runs through the tip of the lower incisor.

In a study comparing persons with cleft palate and normal persons, Buck[2-4] utilized Hixon's measurement system with slight modifications.

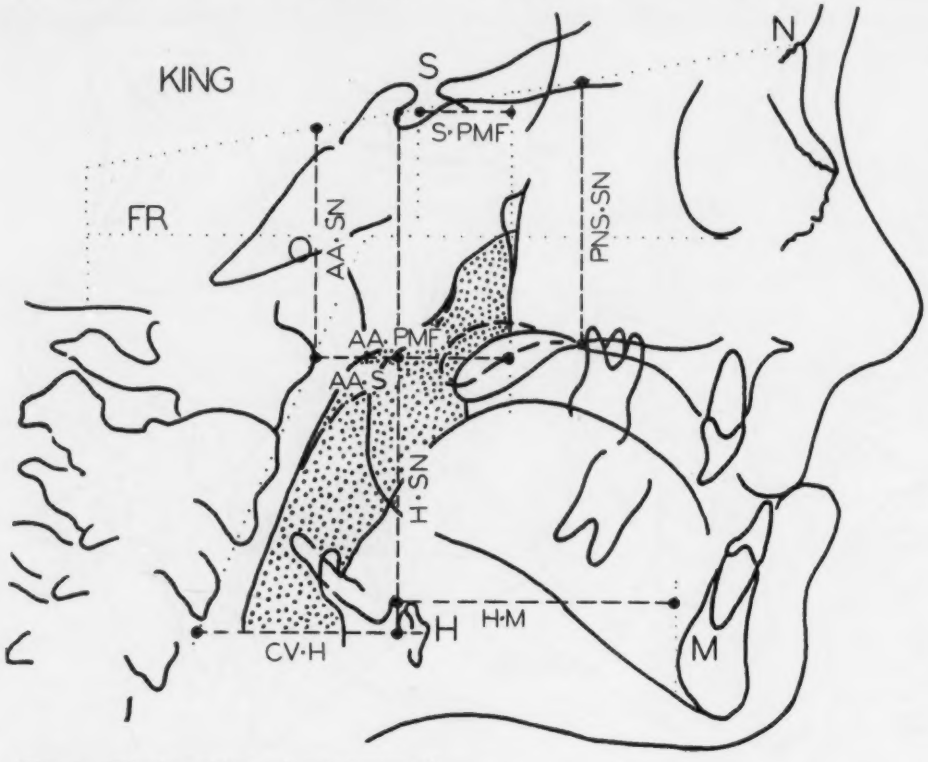

Fig. 3.—King's system of measurement.

Horizontal measurements:

AA-S	=	Anterior tubercle of atlas to projection of sella.
AA-PMF	=	Anterior tubercle of atlas to pterygomaxillary fissure.
S-PMF	=	Sella to projection of pterygomaxillary fissure.

Vertical measurements:

SN-AA	=	Sella-nasion plane to anterior tubercle of atlas.
SN-PNS	=	Sella-nasion plane to posterior nasal spine.
SN-H	=	Sella-nasion plane to hyoid.
M-H	=	Most posterior point of mandibular symphysis to hyoid.
CV-H	=	Cervical tangent to hyoid.

King,[13] in 1952, used lateral cephalometric radiographs taken from the Broadbent-Bolten Growth Study to measure vertical and horizontal growth change in the oral and nasal pharynx. King's measurement system (Fig. 3) used the Frankfort plane as the basic reference line.

In 1952 Willis[26] presented a measurement system based on the Frankfort plane. Structures related to the soft palate and nasopharynx were measured between lines drawn parallel or vertical to the Frankfort plane. This measurement system may be considered a grid similar to that used by Wolfe and Hixon. Willis also measured the area of the nasopharynx and soft palate, using a technique described by Tirk.[23]

In 1953 I studied the relationship between velopharyngeal valving competence and nasal emission in persons with cleft palate.[24] I established a ratio between the distance the soft palate moved toward closure during phonation and the size of the velopharyngeal aperture at rest. As shown in Fig. 4, these distances were measured along a line drawn through the area of maximum velopharyngeal closure. This measurement was used to express, in percentage, the degree to which the soft palate could close the velopharyngeal aperture. In a

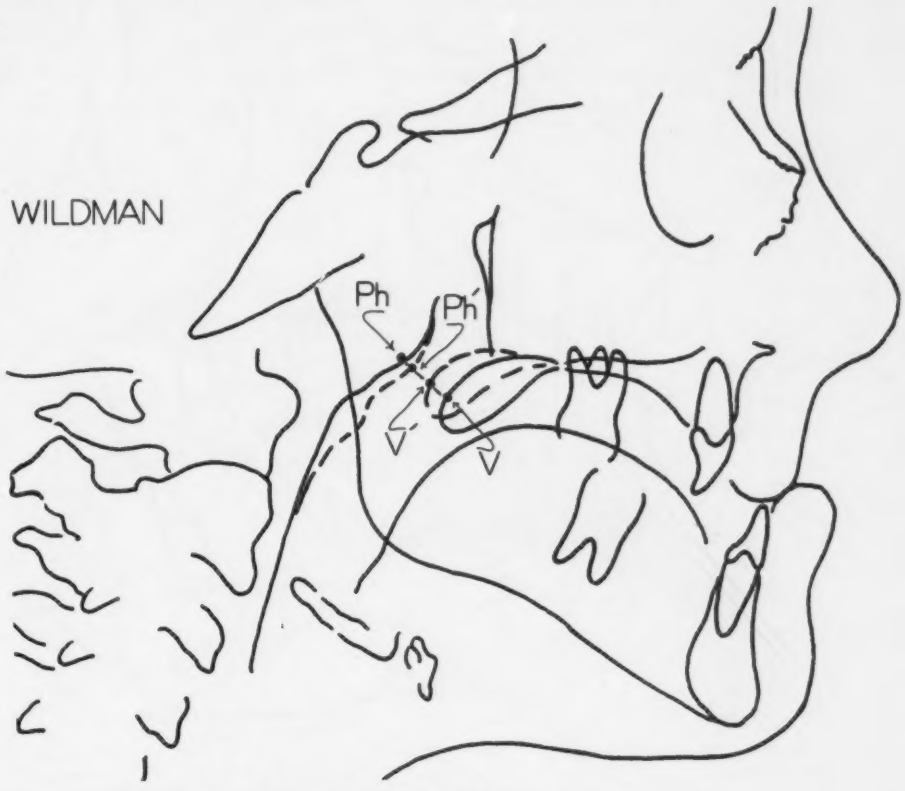

Fig. 4.—Wildman's measurements of velopharyngeal area.

$\frac{V\text{-}V'}{Ph\text{-}V}$ = Degree to which soft palate closes velopharyngeal aperture during phonation.

$\frac{Ph\text{-}Ph'}{Ph\text{-}V}$ = Degree to which posterior wall closes velopharyngeal aperture during phonation.

$\frac{V\text{-}V' + Ph\text{-}Ph'}{Ph\text{-}V}$ = Degree to which soft palate plus posterior pharyngeal wall close velopharyngeal aperture during phonation.

similar manner, I also measured the anterior movement of the posterior wall of the pharynx. In a third measurement, I compared the movement of the soft palate plus the movement of the posterior pharyngeal wall to the measurement of the velopharyngeal aperture at rest. The use of ratios permitted persons of greatly varying size to be compared with some degree of reliability.

In 1954 Ricketts[18] suggested that the variation of the cranial base might be an underlying factor affecting velopharyngeal valving competence. He pointed out that as the cranial base opened up or became more obtuse, the posterior wall and the soft palate would be more widely separated, thus increasing the possibility of velopharyngeal incompetence.

In 1956 McKee[15] used the occlusal plane as a reference line from which he measured tongue height.

Joanne Subtelny's[22] dissertation, completed in 1956, contained an excellent analysis system designed to measure individual variation in the structures of the oral and nasal speech mechanism (Figs. 5 and 6). Subtelny noted that the voice tract was divided into an anterior and a posterior cavity by the arching of

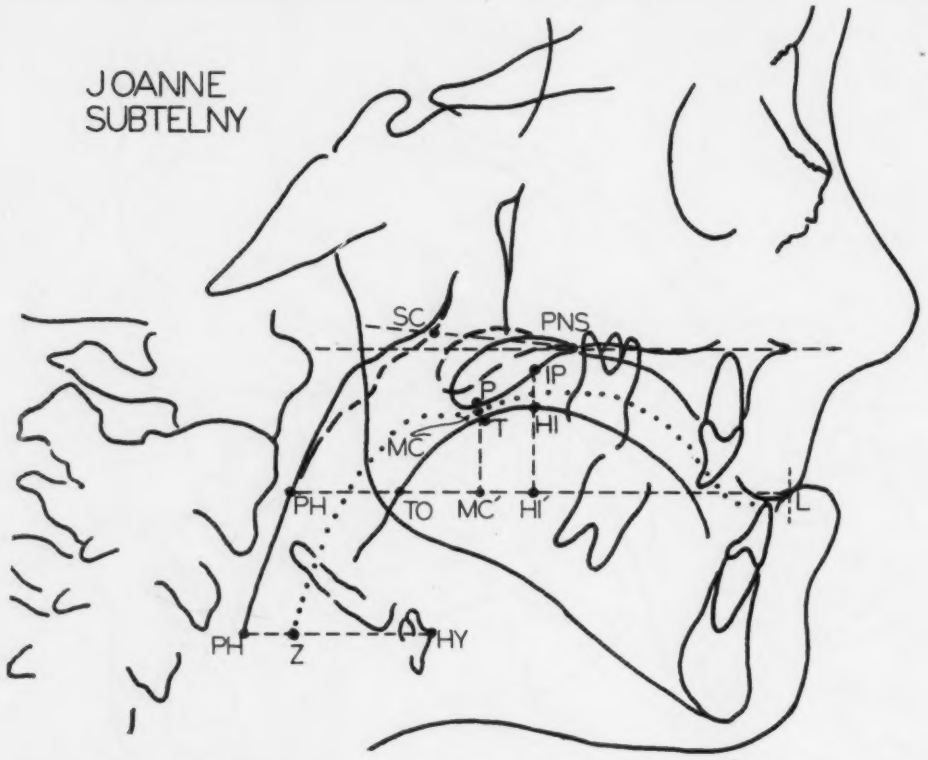

Fig. 5.—Joanne Subtelny's system of measurement.

Vertical measurements:

PP-HY PH	= Palatal plane to hyoid-pharyngeal plane as measurement of oropharyngeal height.
HI-IP	= High point of tongue to inferior aspect of palate as measurement of vertical tongue position.
T-P	= Tongue to palate at point or midpoint of maximum constriction.

Cavity lengths:

L-MC	= Anterior cavity length measured along line bisecting oropharyngeal cavity.
MC-Z	= Posterior cavity length measured along line bisecting oropharyngeal cavity.
L-MC Z	= Total cavity length measured along line bisecting oropharyngeal cavity.
$\frac{L\text{-}MC}{L\text{-}MC\ Z}$	= Proportional length of anterior cavity.

Horizontal measurements:

L-HI'	= High point of tongue (projected) to lip aperture on oral cavity reference line.
L-MC'	= Point of maximum constriction (projected) to lip aperture on oral cavity reference line.
TO-PH	= Posterior aspect of tongue to posterior pharyngeal wall on oral cavity reference line.
L-PH	= Total oral cavity length on oral cavity reference line.
$\frac{L\text{-}HI'}{L\text{-}PH}$	= Proportional horizontal location of high point of tongue.
$\frac{L\text{-}MC'}{L\text{-}PH}$	= Proportional horizontal of point of maximum constriction.

Velar measurement:

PNS SC-PP angle = Degree of velar elevation in reference to palatal plane.

the tongue during phonation, and she based her measurements on this fundamental consideration. She measured the length and area of the anterior and posterior cavities and expressed the length of the anterior cavity as a proportion of the total cavity length. Subtelny also developed an oral cavity reference line which was constructed parallel to the palatal plane, passing through the confluence of the lips. This line is similar to the previously mentioned incisal reference line and the occlusal plane. Subtelny's basic approach is sound. She resisted the temptation to measure all variables from some basic reference line drawn off in space through unrelated anatomic structures. Her measurements appear to be based on a knowledge of the anatomy and physiology of the oral structures used in speech.

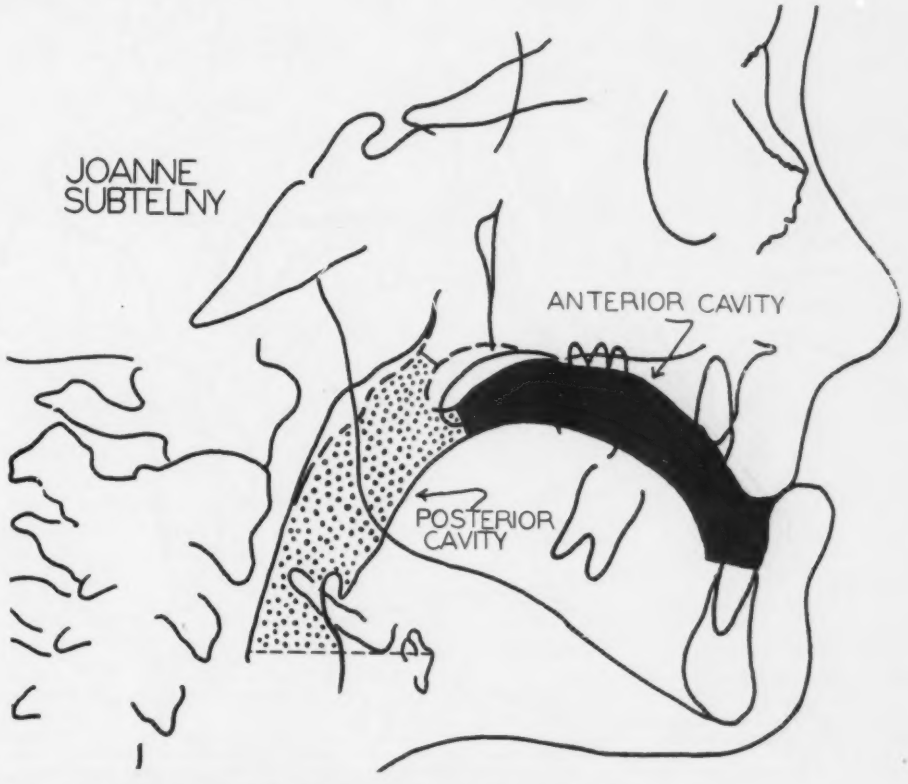

Fig. 6.—Joanne Subtelny's measurements of cavity areas.
Anterior cavity = Space formed during phonation anterior to point of maximum constriction.
Posterior cavity = Space formed during phonation posterior to point of maximum constriction.
Total cavity area = Total area of oropharngeal cavities during phonation.

In 1957 J. Daniel Subtelny[21] published a study of growth of the soft palate in normal persons as visualized in serial cephalometric radiographs. His measurement system (Fig. 7) used the palatal plane as a basic reference line. The angle of the soft palate from the palatal plane was recorded for the subject at various age levels. Horizontal growth was represented by the distance from the posterior nasal spine to the posterior pharyngeal wall as measured along the palatal plane. The height of the nasopharyngeal space was represented by the

distance between the posterior nasal spine and the nasion-basion plane as measured along a perpendicular to the palatal plane passing through the posterior nasal spine.

Brader,[1] in 1957, presented a cephalometric x-ray study of morphologic variations in cranial base and pharyngeal structures. He was not interested in the movements of the soft-tissue structures during speech but was concerned, rather, with the morphologic variation between persons x-rayed with

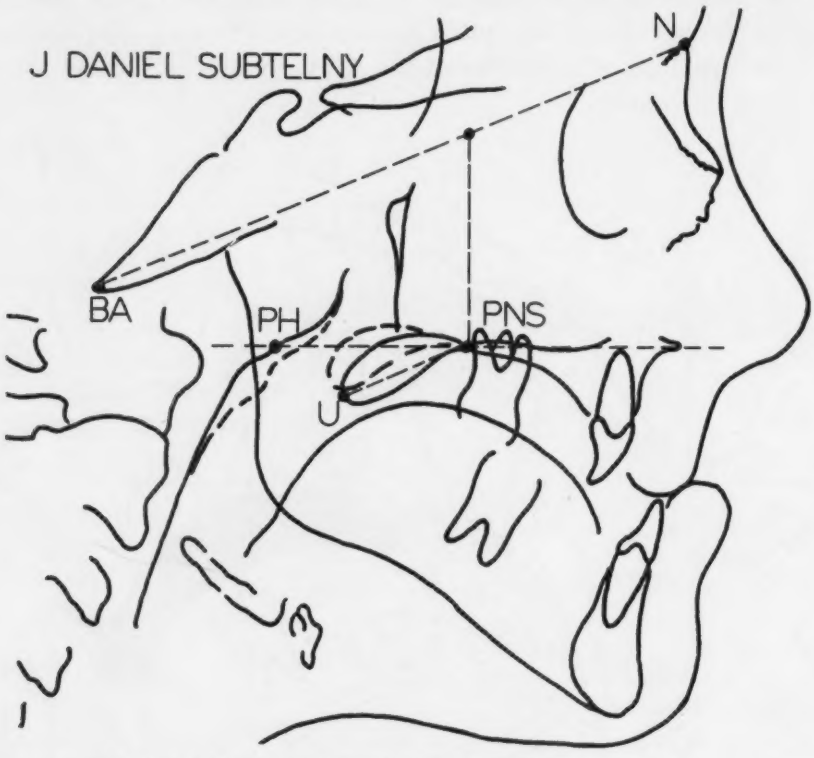

Fig. 7.—J. Daniel Subtelny's system of measurement.

Linear measurements:

PNS-uvula	=	Length of resting soft palate in millimeters.
Oral surface—nasal surface of soft palate	=	Thickness of soft palate.
N BA-PNS	=	Distance of posterior nasal spine from nasion-basion plane as measured along line drawn through posterior nasal spine and drawn perpendicular to palatal plane.
PNS-PH	=	Distance along palatal plane from posterior nasal spine to posterior pharyngeal wall.

Measurements expressed as ratios:

$\frac{PNS\text{-}PH}{Velar\ length} \times 100$ = Percentage expression of ratio between velar length and width of nasal pharynx measured along palatal plane.

Angular measurement:

ANS-PNS-velar plane = Angle assumed by soft palate in relation to palatal plane.

their teeth in occlusion. He compared cleft palate and normal persons to ascertain what variation, if any, could be determined between the two groups. Brader's analysis system (Figs. 8 and 9) included extensive angular, linear, and areal measurements. Of the many measurements that Brader used, only two successfully differentiated persons with cleft palate from normal persons at the 1 per cent confidence level. These were the angle S-BA-PMF, which

represented the relative superoinferior position of the pterygomaxillary fissure, and the linear measurement AT-PMF, which represented the distance between the outline of the adenoid tissue and the pterygomaxillary fissure. A third significant measurement was the areal measurement TAT, which indicated the oropharyngeal area. This was significant at the 5 per cent confidence level.

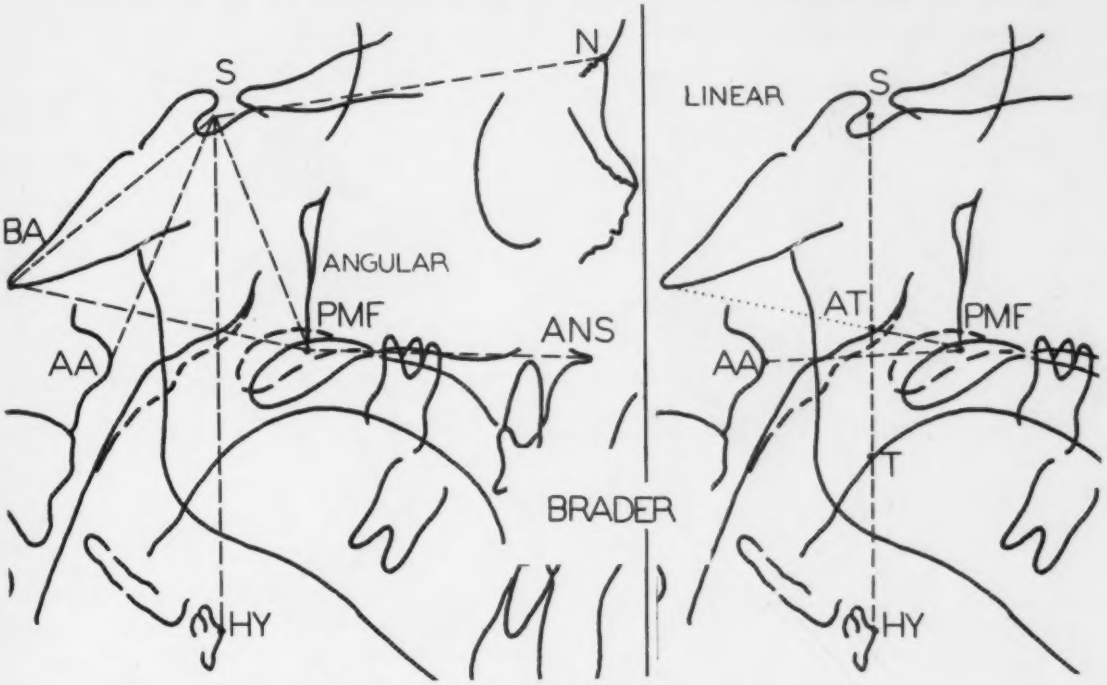

Fig. 8.—Brader's linear and angular measurements.

Angular measurements:

N-S-BA	=	Angularity of cranial base.
N-S-AA	=	Relative anteroposterior position of anterior tubercle of atlas.
N-S-HY	=	Relative anteroposterior position of hyoid bone.
N-S-PMF	=	Relative anteroposterior position of pterygomaxillary fissure.
BA-S-PMF	=	Degree of interspace between basion and pterygomaxillary fissure.
AA-S-PMF	=	Degree of interspace between anterior tubercle of atlas and pterygomaxillary fissure.
S-BA-PMF	=	Relative superoinferior position of pterygomaxillary fissure.
S-PMF-HY	=	Relative anteroposterior position of body of hyoid bone.

Linear measurements:

AT-PMF	=	Distance between outline of adenoid tissue and pterygomaxillary fissure along line joining basion-pterygomaxillary fissure.
AA-PMF	=	Anterior arch of atlas (approximate position of Passavant's pad) to point of juncture of pterygomaxillary fissure with plane of hard palate.
S-AT	=	Distance between sella and adenoid tissue as measured along line joining sella and hyoid bone.
AT-T	=	Distance between adenoid tissue and tongue as measured along line joining sella and hyoid bone.
T-HY	=	Distance between tongue and hyoid bone as measured along line joining sella and hyoid bone.
S-HY	=	Distance between sella and hyoid bone as measured along line joining sella and hyoid bone.

In 1958 Hagerty and associates[9, 10] published a laminagraphic study of posterior pharyngeal wall movement and soft palate function. Their analysis system used a basic reference line, called AA, drawn through the anterior nasal spine and the midpoint of the tubercle of the atlas. Another line, called YY, was constructed perpendicular to AA, passing through the midpoint of the tubercle of the atlas. Posterior wall movement was measured from line YY at

four arbitrarily selected levels, 1 cm. apart. The first level was 1 cm. below line AA, the second was at the level of AA, the third was 1 cm. above line AA, and the fourth was 2 cm. above line AA. This measurement has obvious disadvantages which limit its application. Hagerty and his co-workers noted: "Subsequent examination of the tracings disclosed that the actual point of greatest excursion occurred much more frequently between two levels (where it missed being measured) than at a given level." They measured velar height

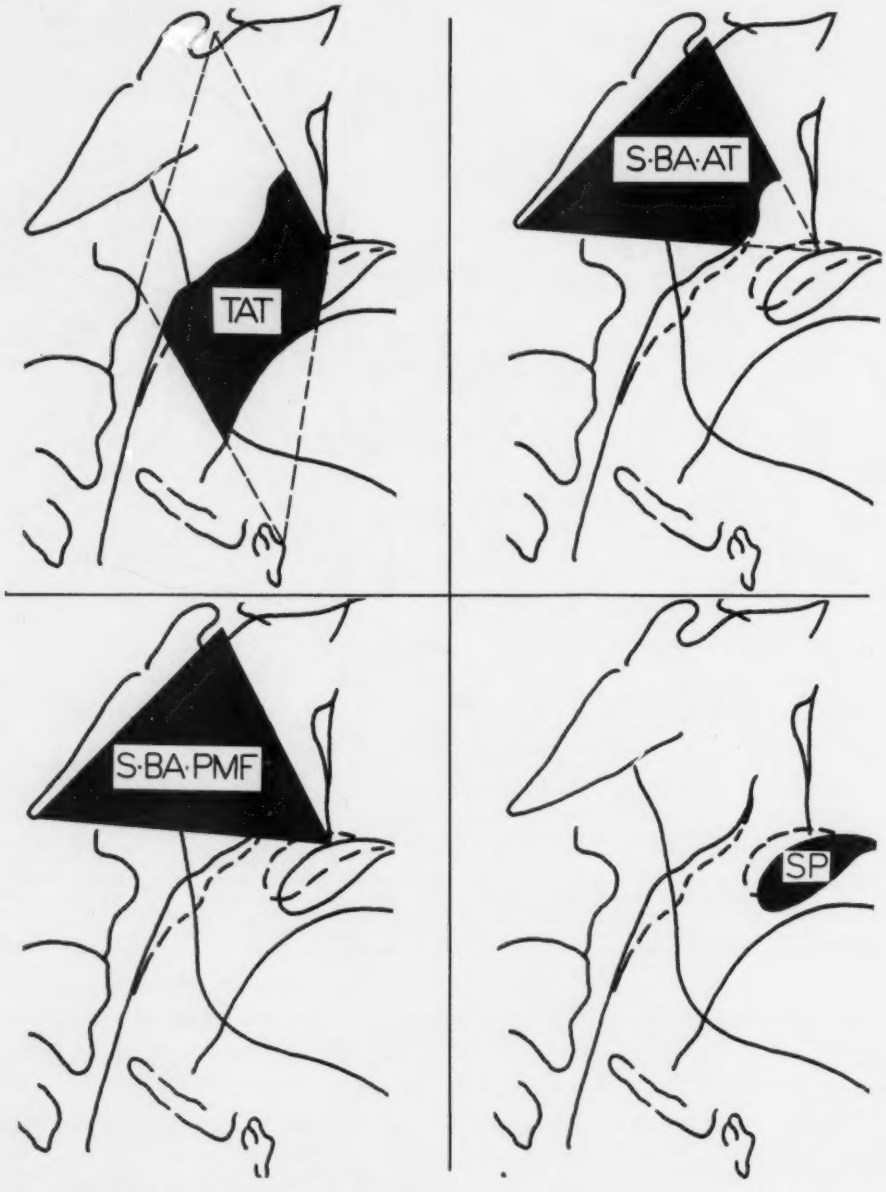

Fig. 9.—Brader's measurements of area.

S-BA-PMF = Indication of size of nasopharyngeal area.
S-BA-AT = Indication of size of nasopharyngeal area and adenoid tissue.
SP = Sagittal cross section of soft palate.
TAT = Size of oropharynx bounded by tongue, adenoid tissue, anterior tubercle of atlas, and pterygomaxillary fissure.

above line AA and the distance of the velum below AA; posterior movement of the velum was measured from line YY. This approach was basically the same as Wolfe's.

In 1958 Fletcher[6, 7] devised a system of measurement in which the relationship of various skeletal points was expressed in terms of angular measurement (Fig. 10). Fletcher also measured the posterosuperior movement of the soft palate during phonation of speech sounds. He used a composite tracing from

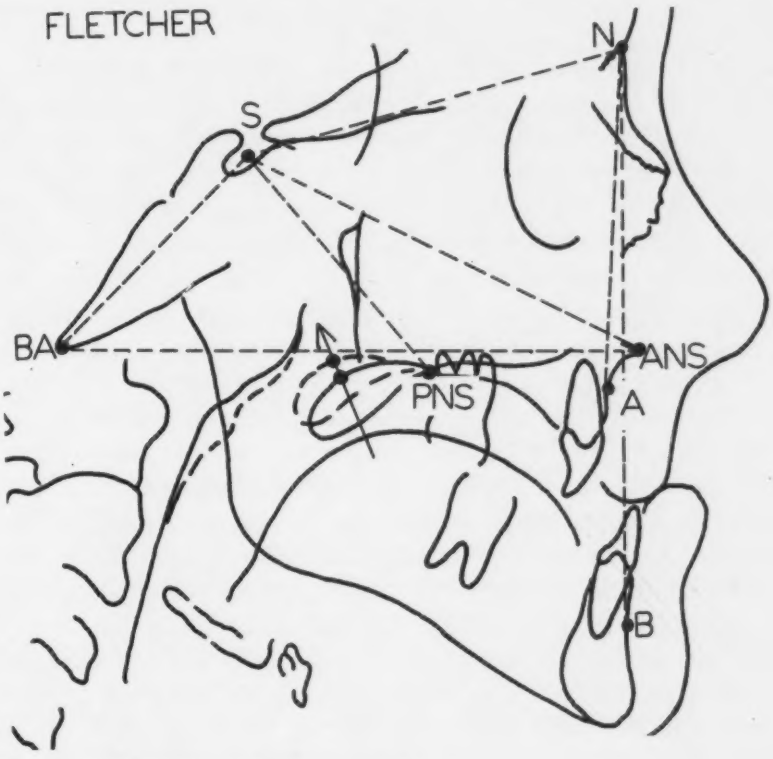

Fig. 10.—Fletcher's system of measurement.

S-BA-ANS	= Descent of anterior nasal spine.
S-BA-PNS	= Descent of posterior nasal spine.
ANS-S-N	= Also shows descent of anterior nasal spine.
ANS-S-PNS	= Reflects palatal size and palatal plane.
S-N-ANS	= Indicates relationship between forward growth of anterior nasal spine and forward cranium.
S-N-A	= Indicates relationship between forward growth of maxillary apical base and anterior cranium.
S-N-B	= Indicates relationship between forward growth of mandibular apical base and anterior cranium.
N-S-PNS	= Reflects relationship between sella turcica and posterior part of hard palate.
BA-S-PNS	= Reflects size of pharynx.
BA-S-N	= Cranial base angle.

lateral cephalometric cinefluorographic films taken during phonation of speech sounds and at rest. The nasal surface of the soft palate, from the posterior nasal spine to the tip of the uvula, was measured at rest and during function. A ratio was established on the nasal surface of the functioning soft palate between the total length of the soft palate and the length of the soft palate from the posterior nasal spine to the insertion of the levator muscles. This ratio was used to mark a point on the nasal surface of the soft palate at rest, thus giving

two points in the arc of the palatal elevation. A line was then drawn through these two points. The angle formed by this line and the palatal plane was used to measure elevation of the soft palate.

Graber and colleagues,[8] in 1959, divided the palate into four quadrants and then noted which quadrant was involved in velopharyngeal closure. They measured the high point of the palate and the midpoint of velopharyngeal valving from the palatal plane. This is basically the same as Wolfe's approach.

DISCUSSION

The measurement of variation between individual persons and between groups of persons requires the careful choice of reference planes from which the variable is to be measured. It must be remembered that there is no such thing as a fixed or completely stable reference plane. If the anatomy and physiology of the area are taken into consideration, however, then it is possible to establish a reference plane which is less variable and more stable than the point which is to be measured.

In my opinion, three criteria should in large part dictate the choice of a reference line for the study of the tongue and velopharyngeal area. (1) This line should be the most stable reference line in relation to the variable to be measured, (2) it should be in functional and anatomic relation to the variable under consideration, and (3) it should introduce as few unnecessary variables as possible. The choice of a reference line for the measurement of tongue height demonstrates the application of these three criteria. One might, for example, choose between the incisal reference line and the palatal plane. The incisal reference line is drawn through the tip of the lower incisor parallel to the Frankfort plane. The tip of the lower incisor is not stable from person to person, and thus it violates the first criterion. This line is drawn through the tip of the lower incisor and also violates the second criterion in that it is not in functional relation with the high point of the tongue. When the incisal reference line is drawn parallel to the Frankfort plane, the third criterion is violated. The use of the Frankfort plane interjects variations associated with porion and orbitale which are beyond the functional region being considered. The palatal plane meets all three criteria of a good reference line. It is relatively stable; the palate is in functional relation with the high point of the tongue; and, since the palatal plane is confined to the immediate anatomic area, no irrelevant variables are introduced. In this comparison of possible reference lines from which to measure tongue height, the palatal plane is the obvious choice. When a choice must be made between two comparable reference lines, the one that most completely satisfies these three conditions should be chosen.

When a reference line is established, measurements from this line should be as simple as possible. Usually, elaborate measurements introduce unnecessary variables. Often it is possible to measure a variable directly, without the use of a reference line. An example of this is the measurement of the velopharyngeal aperture. Many complicated measurements have been used to measure velopharyngeal closure, but the most reliable of these is the direct and simple millimeter measurement of the aperture itself.

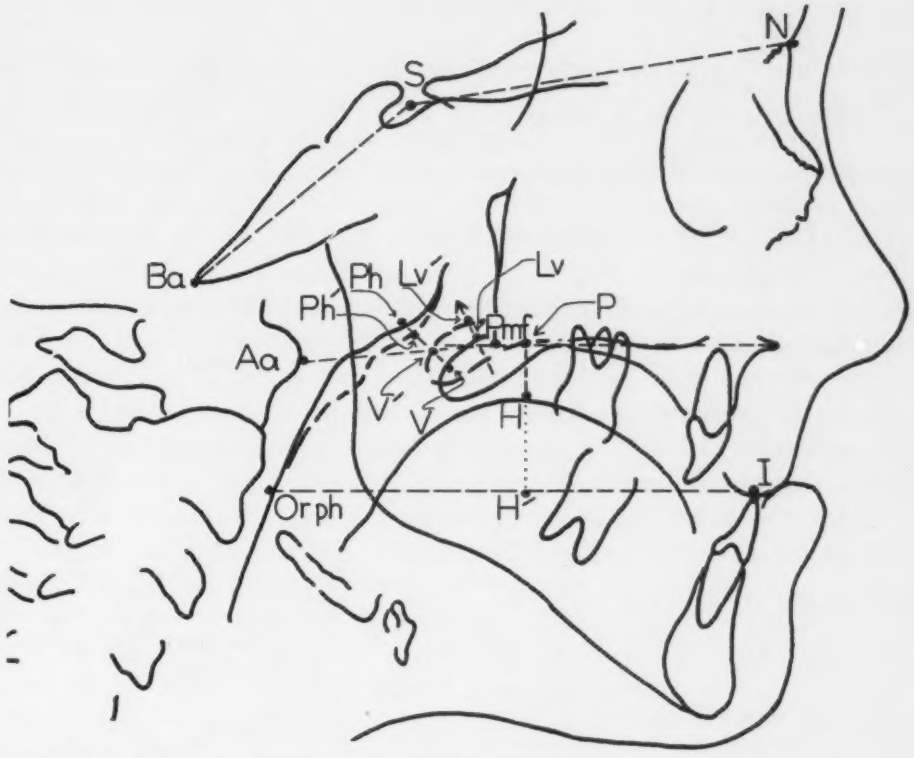

Fig. 11.—Measurement system proposed for use at the University of Oregon.

Reference points and lines:

Aa	=	Anterior tubercle of atlas.
Ba	=	Basion.
H	=	High point of tongue.
H'	=	High point of tongue projected on incisal reference line.
I	=	Tip of lower incisor.
I-Orph	=	Total oral cavity length measured along incisal reference line drawn through tip of lower incisor. (In this study this line is drawn parallel to the palatal plane; Hixon originally drew it parallel to the Frankfort plane.
I-H'	=	Anterior oral cavity length measured along incisal reference line.
Lv	=	Insertion of levator muscles in resting velum.
Lv'	=	Insertion of levator muscles in functioning velum.
N	=	Nasion.
P	=	Intersection of palatal plane and line drawn perpendicular to palatal plane through high point of tongue.
Orph	=	Intersection of incisal reference line with posterior wall of oropharynx.
Ph	=	Intersection of posterior pharyngeal wall at rest and line drawn through area of maximum velopharyngeal closure.
Ph'	=	Intersection of posterior pharyngeal wall at function and line drawn through area of maximum velopharyngeal closure.
S	=	Sella.
V	=	Intersection of superior surface of velum at rest and line drawn through area of maximum velopharyngeal closure.
V'	=	Intersection of superior surface of velum during function and line drawn through area of maximum velopharyngeal closure.

Measurements of tongue position:

H-P	=	High point of tongue to palatal plane.
$\frac{I\text{-}H'}{I\text{-}Orph}$	=	Ratio between anterior oral cavity length and total oral cavity length.

Measurements of velopharyngeal valve:

$\frac{V'\text{-}Ph'}{V\text{-}V'}$	=	Velopharyngeal aperture during phonation.
$\frac{V\text{-}V'}{Ph\text{-}V}$	=	Velopharyngeal movement from rest to function divided by velopharyngeal aperture at rest.
$\frac{Ph\text{-}Ph'}{Ph\text{-}V}$	=	Posterior pharyngeal wall movement from rest to function divided by velopharyngeal aperture at rest.
$\frac{Ph\text{-}Ph' + V\text{-}V'}{Ph\text{-}V}$	=	Posterior wall plus velar movement divided by velopharyngeal aperture at rest.
LvLv' line—palatal plane angle	=	Velar angle of movement measured from palatal plane.
Lv-Lv'	=	Distance between insertion of levator muscles in resting palate and insertion of levator muscles in velum during phonation.

Skeletal measurements:

Aa-Pnf	=	Nasopharyngeal width between anterior tubercle of atlas and pterygomaxillary fissure.
NSBa angle	=	Cranial base angle.

Measurements should be expressed as angles or proportions instead of linear measurements, whenever possible, to eliminate variation related to the size of the individual patient. Linear measurements are sometimes chosen over angular measurements or ratios when the linear measurement is more direct and introduces the fewest variables. This is often more important than the size factor.

It should be stated that the measurements discussed here pertain to tracings of lateral radiographs of the head. The use of cephalometric techniques is essential if measurements of different radiographs are to be comparable. Lateral radiographs present a two-dimensional picture of three-dimensional phenomena. This should be considered in the interpretation of these films. When used with a knowledge of its limitations, lateral cephalometric radiology is a valuable clinical and research tool for the evaluation of tongue and velopharyngeal function.

The following measurement system (also shown in Fig. 11) is based on those measurements in the literature which meet the established criteria and seem likely to provide the most information.

MEASUREMENT OF TONGUE POSITION:

High point of tongue to palatal plane, in millimeters (modified from Hixon) —Locates the high point of the tongue in a vertical plane.

Projected high point of tongue to tip of lower incisor on the incisal reference line / Oral cavity length on incisal reference line from tip of lower incisor to posterior wall of pharynx (from Hixon, Buck, and Subtelny) —Locates the high point of the tongue in a horizontal plane.

MEASUREMENT OF VELOPHARYNGEAL VALVE:

Velopharyngeal aperture during phonation, in millimeters —Linear measurement of velopharyngeal valve at the narrowest point during phonation.

Velar movement from rest during phonation / Velophargnyeal aperture at rest (Wildman) —Degree to which the soft palate closes the velopharyngeal aperture during phonation.

Posterior pharyngeal wall movement from rest during phonation / Velophargnyeal aperture at rest (Wildman) —Degree to which posterior pharyngeal wall closes the velopharyngeal aperture during phonation.

Velar + posterior wall movement from rest during function / Velopharyngeal aperture at rest (Wildman) —Degree to which the soft palate and posterior pharyngeal wall close the velopharyngeal aperture during phonation.

Velar elevation—palatal plane angle (Fletcher) —Describes the direction the palate moves toward closure.

Velar elevation to palatal plane, in millimeters (Fletcher) —Linear measurement between the insertion of the levator muscles in the resting palate and the insertion of the levator muscles in the functioning palate.

SKELETAL MEASUREMENTS:

Anterior tubercle of atlas to posterior maxillary fissure, in millimeters (Brader)	—Represents nasopharyngeal width.
Nasion—sella—basion angle (Ricketts)	—Cranial base angle.

The reasons for the choice of one measurement over another will now be discussed.

Measurement of Tongue Position.—There are several anatomic considerations upon which intelligent measurement of the tongue can be based. The skeletal structures to which the tongue is attached are the hyoid bone, the mandible, and the styloid process. If these bones constitute the area of insertion from which the tongue moves, then a reference line based on points in the hyoid bone and the mandible might provide some common basis from which to judge the variations in tongue position from one person to another. The hyoid bone and the mandible are highly mobile structures and cannot be considered a relatively stable reference area, even though they are anatomically and structurally related to the tongue. A more attractive possibility is seen in the fact that the tongue moves within the oral cavity and the oral pharynx and hence is limited in its motion by the walls of these cavities. The comparison of individual variation in tongue position in terms of the relationship between the tongue and the walls of the oral cavity in which it moves is a reasonable approach.

The reference plane chosen for the comparison of vertical tongue position is the palatal plane, which represents the superior limits of the oral cavity. The tongue and the hard palate form a part of the oral resonating chamber during speech and are in functional relationship during deglutition. It is reasonable to compare the relationship of the tongue to the palatal plane which represents, essentially, the roof of the mouth.

If the tongue is to be measured in terms of the palatal plane, then it is necessary to establish some point or place on the tongue from which measurement can be made. Establishment of landmarks in an indefinite and highly mobile soft-tissue structure, such as the tongue, presents a difficult problem. Early investigators interested in speech used the high point or arching point of the tongue to compare tongue position between individual persons. Since this is both classic and logical, the high point has been chosen as a basic reference point. The arching point of the tongue is not as discrete as many of the skeletal landmarks, but it does identify the superior limits of the tongue at any given time.

The suggested vertical measurement of tongue position is the linear distance, in millimeters, between the high point of the tongue and the palatal plane, measured along a perpendicular to the palatal plane and passing through the high point of the tongue. Hixon used this basic idea in one of his measurements. He constructed a line through the posterior nasal spine parallel to the Frankfort plane to represent the palate and measured the high point of the tongue from this plane. Since the palatal plane and the Frankfort plane are not usually parallel, a line drawn through the posterior nasal spine parallel

to the Frankfort plane would not necessarily represent the palate accurately. The palatal plane may be used as a basic reference line, replacing the Frankfort plane which introduces unnecessary variables.

Hixon also measured tongue height from a line which he called the incisal reference line. This line is drawn through the tip of the lower incisor parallel to the Frankfort plane. The distance from the high point of the tongue to this plane was measured in millimeters. The total area of the tongue above the incisal reference plane was also measured. The tip of the lower incisor is, itself, extremely variable. It is difficult to understand how a line drawn through this structure can be considered even relatively stable. For example, when the lower incisors have been depressed as a result of orthodontic treatment, a greater area of tongue would protrude above the incisal reference line. From this, we might be tempted to conclude that orthodontic treatment produces a higher tongue carriage, when actually the lower incisors have been depressed. Unfortunately, the less reliable of the two measurements of tongue height which Hixon introduced, namely, that based on the incisal reference line, has been widely accepted.

Recently the incisal reference line was used to measure differences in tongue carriage between groups of normal persons and persons with cleft palate and between groups of subjects with repaired and unrepaired cleft palate.[5, 14] The lower incisors in cleft palate patients are under abnormal influences and may be considered even less stable than the lower incisors of normal persons. Joanne Subtelny used the inferior aspect of the palate to locate the high point of the tongue. During the phonation of some speech sounds the tongue is in relation with the inferior aspect of the hard palate, but during the phonation of other speech sounds it is in relation with the soft palate. Since the soft palate is an intensely mobile structure, it should not be used as a basic reference area. This measurement cannot be considered a measurement of tongue height alone but should be qualified and referred to as a relationship between the tongue and the inferior aspect of the palate. The lateral radiograph of the cleft palate patient used to illustrate the various measurement systems, as in Figs. 5 and 6, shows the high point of the tongue in relation to the velum during rest.

Horizontal tongue position is much simpler to measure than vertical tongue position. Almost any horizontal plane passed through the center of the oral cavity may be used as a reference plane, since the horizontal position of the tongue may be expressed as a ratio of the total oral cavity length.

Hixon used the incisal reference line passing through the tip of the lower incisor parallel to the Frankfort plane to measure horizontal tongue position. He measured the distance from a projection of the anterior nasal spine to the projection of the high point of the tongue on the incisal reference line. He also measured the projection of the anterior nasal spine to the posterior pharyngeal wall on the incisal reference line. Buck used Hixon's system and expressed these two measurements as a ratio.

Joanne Subtelny used a reference line passing through the bisection of the lips parallel to the palatal plane, which she called the oral reference line. She measured the distance between the high point of the tongue and the lip aperture on the oral cavity reference line. She also measured the total oral cavity length on the oral cavity reference line and expressed these two measurements as a ratio, giving the proportional horizontal location of the high point of the tongue.

The horizontal tongue position measurement chosen for the analysis system proposed in this article combines the ideas of Hixon, Buck, and Subtelny. The anterior oral cavity length from the projection of the high point of the tongue to the tip of the lower incisor measured along the incisal reference line and the total oral cavity length from the tip of the lower incisor to the posterior pharyngeal wall along the incisal reference line are expressed as a ratio. Although a line drawn through the tip of the lower incisor should not be used to measure vertical tongue height, it is acceptable for the measurement of horizontal tongue position, since the tip of the lower incisor may be used to represent the anterior limits of the oral cavity and also since it is in functional relation to the tip of the tongue. It is suggested, however, that the incisal reference line be drawn parallel to the palatal plane instead of to the Frankfort plane.

Measurement of the Velopharyngeal Valve.—The velopharyngeal closure mechanism is a complex muscular valve. During velopharyngeal closure the soft palate moves posteriorly to contact the posterior pharyngeal wall. The lateral walls of the pharynx move mesially, and the posterior wall of the pharynx may sometimes move anteriorly. This anterior protuberance of the posterior wall is usually referred to as Passavant's pad.

It should be emphasized that in the measurement of velopharyngeal closure from lateral cephalometric radiographs a three-dimensional phenomenon is expressed in terms of two dimensions. It would be desirable to measure the total area of the velopharyngeal aperture, but no method for doing so is available. At the present time lateral cephalometric radiographs must be accepted as the best method of visualizing the function of the velopharyngeal valve.

The criterion of how well a valve functions is the efficiency with which it closes. Many of the measurement systems found in the literature fail to include a direct measurement of velopharyngeal closure. The millimeter measurement of the valve at the narrowest point of closure is obviously the most important criterion by which the completeness of velopharyngeal valving may be determined. The use of a linear measurement does involve problems of variation in size between persons. To compensate for this, I developed a ratio between the millimeter measurement representing the movement of the soft palate toward closure during phonation and the millimeter measurement of the velopharyngeal valve during rest. This expressed, in percentages, the degree to which the soft palate closed off the velopharyngeal space. A similar ratio was established between the velopharyngeal valve aperture at rest and the anterior movement of the posterior pharyngeal wall during phonation. A third ratio was established between the measurement of the velopharyngeal valve aperture

at rest and a measurement combining the movement of the soft palate and the movement of the posterior wall during phonation. These measurements are recommended.

After the closing efficiency of a valve is measured, the movements of various parts of the valve during closure should be considered. In the velopharyngeal valve the principal moving structure is the soft palate. It should be remembered that the following measurements relate only to soft palate movement and are not necessarily directly related to velopharyngeal efficiency. A highly active soft palate still may not completely close off the velopharyngeal aperture. In the past there has been a tendency to interpret the vertical and horizontal measurements of soft palate movement as direct criteria of velopharyngeal valving efficiency. This is incorrect. The only direct criterion of valving efficiency should be the degree of velopharyngeal closure.

Fletcher expressed the relationship of various skeletal points in terms of angular measurement. He also measured the posterosuperior movement of the soft palate during phonation of speech sounds. He used a composite tracing of lateral cephalometric radiographs taken during phonation of speech sounds and at rest. The nasal surface of the soft palate from the posterior nasal spine to the tip of the uvula was measured at rest and during function. A ratio was established on the nasal surface of the functioning soft palate between the total length of the soft palate and the length of the soft palate from the posterior nasal spine to the insertion of the levator muscles. This ratio was used to mark a point on the nasal surface of the soft palate at rest, thus giving two points in the arc of the palatal elevation. A line was then drawn through these two points. The angle formed by this line and the palatal plane was used to measure elevation of the soft palate.

Fletcher also measured the distance, in millimeters, between the point representing the insertion of the levator muscles in the resting palate and the point representing their insertion in the functioning palate. This is a satisfactory way of describing the degree of soft palate movement. This measurement is included in my measurement system. It should be mentioned once more that a measurement describing soft palate movement, although it is valuable as such, is not necessarily a reliable criterion of velopharyngeal valving efficiency.

Wolfe measured velar height from the palatal plane, which he called the nasal reference line. He measured the posterior border of the velum from a perpendicular of the nasal reference line drawn through the anterior tubercle of the atlas. In this system soft palate movement was resolved into a vertical and a horizontal component. This approach has been used with some modifications by Hixon, Buck, Hagerty, and Graber.

J. Daniel Subtelny measured the angle formed between the palatal plane and a line describing the long axis of the resting palate drawn through the posterior nasal spine. This angle can be used for measuring the posture of the resting palate between groups of persons or, as Subtelny used it, to measure the same person during growth. This angle is not appropriate for comparing

the position of the resting palate to the position of the palate during function. In many cases the soft palate during function assumes an irregular shape through which no one long axis can be drawn.

Another approach to the measurement of velar function was suggested by Graber. He divided the superior surface of the soft palate into four equal quadrants and then noted which quadrant contacted the posterior pharyngeal wall during soft palate function. This measurement would be of value for purposes of description. Its accuracy depends upon the accuracy with which the posterior termination of the soft palate can be determined. Although the soft palate's posterosuperior surface is usually clear, its termination is often obscured. This is particularly true in persons with cleft palate.

Skeletal Measurements.—We have been discussing measurements of the soft tissue structure associated with velopharyngeal valving. The review of the literature reveals that considerable attention has been paid to variation in the skeletal structure supporting the soft tissue of the velopharyngeal valving mechanism.

These measurements of skeletal variation cannot be considered direct criteria of velopharyngeal valving efficiency. The soft tissue structures often have a remarkable ability to compensate. Skeletal imbalance will affect velopharyngeal efficiency only when the soft tissue is unable to compensate for this imbalance. Diagnosis of velopharyngeal incompetence from variation in the skeletal structure does not appear to be good practice. A knowledge of the relationship between soft tissue function and skeletal variation is important for a complete understanding of velopharyngeal physiology.

Ricketts has suggested that variation of the cranial base angle may affect the anteroposterior dimensions of the nasopharyngeal area. Since the soft palate is associated with the anterior cranial base and the posterior pharyngeal wall with the posterior cranial base, an opening-up of the cranial base angle should provide greater distance in the nasopharyngeal space between the soft palate and the posterior pharyngeal wall. Brader used the cranial base angle to compare cleft palate patients and normal subjects and could find no significant difference. If the variation in cranial base angle was compared to palatal function in a large group of persons with cleft palate, with other variables controlled as carefully as possible, then the relationship between soft tissue function and the cranial base angle might become apparent. This measurement has been incorporated into the proposed measurement system.

Brader used a large number of linear, angular, and areal measurements in an attempt to differentiate between cleft palate patients and normal persons. Three of these measurements showed significant differences between normal and cleft palate groups. The significant measurements were the angle S-BA-PMF, the linear measurement AT-PMF, and the areal measurement T-AT (Fig. 7). It should not be assumed that a measurement which differentiated cleft palate persons from normal persons on a morphologic basis is necessarily related to velopharyngeal function.

One of the measurements which Brader used was the linear measurement from the anterior tubercle of the atlas to the point of junction of the pterygomaxillary fissure with the plane of the hard palate. The use of this measurement as a criterion of nasopharyngeal width is recommended. King measured the distance between the anterior tubercle of the atlas and the posterior nasal spine. This measurement would be ideal except for the difficulty in locating the posterior nasal spine, particularly in persons with cleft palate. Variation in the position of skeletal structures affects the positions of associated soft tissue structures. With this measurement Brader could not demonstrate variation between his cleft palate and control groups. The fact that there was no significant variation between the control group and the cleft palate group when measurement AA-PMF was used is not necessarily an indication that this measurement is of no value; rather, it indicates that no variation exists between cleft palate subjects and normal persons on a morphologic basis. If this measurement were used in a research situation in which it was compared specifically to function, then perhaps a significant relationship might be established. At the present time it seems reasonable to assume that a measurement reflecting the width of the oral pharynx should be related to velopharyngeal function.

Fletcher devised an interesting system of angular measurements locating various hard tissue structures related to the velopharyngeal area and the cranial base. This system would apply to variation in maxillary size more directly than to variations related to velopharyngeal function.

The preceding measurements have all been applied to the static analysis of individual persons. A knowledge of the changes in hard tissue structure of the velopharyngeal area during growth is important for a complete understanding of the effects of growth upon velopharyngeal function.

Rosenberger[19] studied growth in the nasorespiratory area and suggested a nasal quadrant drawn between the nasion-sella and palatal planes which roughly delineated the nasal cavity.

Tirk[23] employed planimetry to measure the nasorespiratory areas. These studies of the nasal area apply only indirectly to measurement of the velopharyngeal areas.

King's study pertains more directly to the velopharyngeal area. He measured the vertical growth changes between the sella-nasion plane and the posterior nasal spine, the atlas, the hyoid bones, and the mandibular symphysis. He also measured the degree of horizontal change between the atlas and sella turcica, between the atlas and the pterygomaxillary fissure, and between sella and the pterygomaxillary fissure. This study has provided valuable information concerning the growth of hard tissue structures related to velopharyngeal function.

Velopharyngeal function is more directly related to growth of soft tissue structures. The problem in the past has been that roentgenograms were taken

for growth studies with the velopharyngeal valve at rest but not during velopharyngeal function. Subtelny measured the growth of the soft palate during rest, using roentgenograms from the Broadbent-Bolton Study Group.

When longitudinal studies of phonatory function become available, using techniques such as cinefluorography or rapid film changes, such as the Fairchild camera, much can be learned concerning the intricacies of velopharyngeal function.

The analysis system which has been proposed here is based on what I consider to be the best procedures reported in the literature. Future plans include testing of the proposed measurement system for reliability under research conditions. It is hoped that this system will contribute to the development of a standard and universally accepted measurement system for analysis of the functions of the tongue and the velopharyngeal valve.

APPLICATIONS

Adequate research techniques for measuring tongue and velopharyngeal areas are being developed along many lines. The problem today is to assemble the various techniques so that a standardized system is available for the exchange of information and ideas in the various disciplines in which these areas are of interest. Lateral cephalometric cinefluorography seems the obvious choice for recording movement of the tongue and velopharyngeal areas. The distortion and size factors could possibly be corrected by comparing single frames of lateral cephalometric cinefluorographs with lateral cephalometric radiographs or with lateral cephalometric laminagraphs. A measurement system, such as the one discussed in this article, is essential for the evaluation of these x-ray films. Information provided by standard and objective measurement of the tongue and velopharyngeal areas should provide needed information concerning a variety of research problems that are of current interest.

The speech pathologist and the cleft palate worker are interested in comparing tongue and velopharyngeal movement to speech and to oral and nasal air flow. While a person is speaking, cinefluorography could record the movements of the tongue and velopharyngeal areas, a tape recorder could be used to record speech sounds, and an air pressure-measuring device could be used to record nasal and oral air flow. Normal patterns for these variables could be established. A wealth of material would emerge for the comparison of these normal patterns with deviant patterns. Research of this nature is being planned at the University of Oregon Medical School by Fletcher[7] and Young.[28]

Another area of current interest to both orthodontists and speech pathologists is the relationship between abnormal patterns of swallowing and orthodontic and speech problems. Normal deglutition has been described in great detail by a number of workers, but these descriptions have never been reduced to objective measurements. Objective measurements of normal deglutition should be established for comparison with similar measurements of abnormal deglutition. This would be of considerable interest to orthdontists, who at the

present time feel that abnormal deglutition is directly related to many of their treatment problems. Many speech specialists believe that problems of sibilant distortion are related to abnormal deglutition.

Once perfected, a research tool for the study of the tongue and velopharyngeal areas, consisting of lateral cephalometric cinefluorography corrected for size and distortion and measured by a standardized analysis system, would certainly find a number of uses. The applications mentioned here are a few of the problems of current interest.

SUMMARY

The purpose of this article has been to review the literature concerning the measurement of tongue and velopharyngeal valve function as visualized in lateral cephalometric radiographs. An analysis system based on the best of the measurements described in the literature has been proposed. The reasons for the selection of these measurements and the rejection of others are discussed.

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Editorial

THE A. A. O. MEETING IN DENVER

THE Rocky Mountain Society of Orthodontists and the fabulous new Denver Hilton Hotel did themselves proud as hosts at the fifty-seventh annual session of the American Association of Orthodontists, which was held in Denver, Colorado, April 16 to 20, 1961. Under the leadership of President William R. Humphrey and General Chairman Lyndon Carman and with the fine cooperation of the local committees, the meeting was, indeed, a great success. The registration was large—1,307 according to the final count.

The gathering really started on Saturday, April 15, when several preliminary meetings were held. However, the 1961 annual session officially began on Sunday, April 16, when the International Orthodontic Society for Research and the Board of Directors of the American Association of Orthodontists held meetings. The American Board of Orthodontics exhibit of case reports was also opened on Sunday.

The enthusiastic grand march on Sunday evening was ushered in with a chuck wagon gong secured from a Ranch Round-Up chuck wagon. This was the occasion of a cocktail party followed by a sumptuous dinner served in a Western atmosphere. The cowboy costumes worn by members of the local committees added much color to the occasion. The dinner reflected a great amount of thought and effort on the part of the committee in charge. The feature attraction subsequent to the dinner was the spectacular entertainment provided by the Koshare Indian Dancers of La Junta, Colorado. This group, a nationally known Boy Scout troop founded in 1933 by J. F. Burshears, has made La Junta the Indian lore capital of the world. The Indian Dancers returned the copper-skinned American Indians of the past from their happy hunting grounds with authenic interpretive dancing. Costumes were made entirely by members of the troop. In addition to performing spectacular war dances, the boys also gave renditions of strange dances honoring Indian gods and festival days of years gone by. Many A. A. O. members recognized the Koshare Indian Dancers as the group recently written up in the *Reader's Digest*.* The Sunday evening festivities will long be remembered as an outstanding feature of the Rocky Mountain meeting. Louis J. Williams of Casper, Wyoming, president of the Rocky Mountain Society of Orthodontists, proved to be a talented master of ceremonies and added much to the occasion with his running account of the evening's activities.

With a membership of about 3,000, the A. A. O. now requires an extra day in advance of the meeting for the first meeting of its Board of Directors. The Board met on Saturday morning in response to a call by President Humphrey

*Friggens, Paul: Burshear's Remarkable Boy Scouts, *Reader's Digest*, February, 1961.

and Secretary Earl Shepard. The American Board of Orthodontics, under the direction of President Wendell L. Wylie of San Francisco, met a week in advance in order to examine candidates for accreditation.

The Public Health Conference was held on Monday morning under the direction of Chairman J. A. Salzmann of New York. The Publications Board and the Editorial Board of the AMERICAN JOURNAL OF ORTHODONTICS also met on Monday morning.

Another outstanding event was the Golden Anniversary Luncheon held at noon Monday, with Vice-President Cecil G. Muller presiding. The principal speaker at the luncheon was Stanley M. Garn of Fels Research Institute, Yellow Springs, Ohio. Chairman Charles R. Baker was in charge of the Golden Anniversary Luncheon, and Henry F. Hoffman of Boulder, Colorado, was the guest of honor. Tribute was paid to Dr. Hoffman for his long-time services to dentistry and orthodontics, particularly in the Rocky Mountain area. (Dr. Baker's special report on the Golden Anniversary Luncheon will appear in a forthcoming issue of the JOURNAL.)

The Albert H. Ketcham Memorial Award was presented on Monday afternoon to William B. Downs of Aurora, Illinois. (A complete formal report of the presentation will be published in a subsequent issue of the JOURNAL.)

The following scientific papers were also presented on Monday:

PRINCIPLES OF CRANIOFACIAL DEVELOPMENT ASSESSED BY EXPERIMENTAL BIOLOGY (the John Valentine Mershon Memorial Lecture). Louis J. Baume, D.M.D., M.S., Professor of Dental Medicine, University of Geneva, Switzerland.

RECENT DEVELOPMENTS IN BIOLOGICAL STUDIES ON THE OSSEOUS SYSTEM. C. Willett Asling, M.D., Ph.D., Professor of Anatomy and Co-Chairman of the Department of Anatomy and Physiology, University of California, Berkeley, California.

USES AND LIMITATIONS OF ELECTROMYOGRAPHY IN THE QUANTITATIVE STUDY OF SKELETAL MUSCLE FUNCTION. Henry J. Ralston, Ph.D., Department of Physiological Sciences, College of Physicians and Surgeons, and the Biomechanics Laboratory, University of California Medical Center, San Francisco, California.

SYSTEMIC DISTURBANCES IN RELATION TO GENERAL AND DENTOFACIAL GROWTH AND DEVELOPMENT IN CHILDREN. John F. Crigler, Jr., M.D., Associate in Pediatrics, Harvard Medical School, and Associate Physician, The Children's Hospital, Medical Center, Boston, Massachusetts; Melvin I. Cohen, D.M.D., Assistant Clinical Professor of Orthodontics, Harvard School of Dental Medicine; and M. H. Wittenborg, M.D., Associate Clinical Professor of Radiology, Harvard Medical School.

On Tuesday morning there was a panel discussion of essays presented at Monday's scientific session. Wendell L. Wylie, president of the American Board of Orthodontics and Professor of Orthodontics at the University of California, served as moderator; panelists were Louis J. Baume, C. Willett Asling, Henry J. Ralston, and John F. Crigler, Jr. Another item on Tuesday's program was a round-table luncheon discussion of orthodontic education.

On Thursday there was a panel discussion of two questions posed by J. A. Salzmann, chairman of the Program Committee: "Are systems limiting our thinking? Are not basic principles more important than systems?" This session, which was arranged with special care, will be reported in more detail later.

One of the high spots of the special events schedule was a Tuesday afternoon tour of the United States Air Force Academy near Colorado Springs, which was topped off by a splendid dinner at the Officers' Club at the Academy. This thrilling event will be described fully in a separate report to be published later.

A digest of the official program follows.

Saturday, April 15

A. B. O. Board of Directors
Qualifying Committee
A. A. O. Board of Directors
International Orthodontic Society for Research

Sunday, April 16

International Orthodontic Society for Research
A. A. O. Board of Directors
A. B. O. Board of Directors
A. B. O. exhibit of case reports
Cocktail party
Dinner
Western hospitality

Monday, April 17

Publication and Editorial Staff breakfast
Official opening of meeting
Ladies' continental breakfast
A. B. O. exhibit of case reports
Mershon Memorial Lecture by Louis J. Baume
Lecture by C. Willett Asling
Luncheon
Ladies' luncheon and fashion show
Golden Anniversary Luncheon
Presentation of Albert H. Ketcham Memorial Award
Lecture by Henry J. Ralston
Lecture by John F. Crigler, Jr.
Public Health Conference

Tuesday, April 18

A. A. O. Board of Directors
General meeting
Ladies' continental breakfast
Panel discussion
A. B. O. exhibit of case reports
First business meeting
Round-table discussion
Tour of Air Force Academy
Research meeting

Wednesday, April 19

Convention-Planning breakfast
Constituent society secretaries' breakfast

General clinics
Ladies' continental breakfast
A. B. O. exhibit of case reports
Board of Directors of Rocky Mountain Society of Orthodontists
Past Presidents' Luncheon
Lecture (Milo Hellman Award)
Lecture (A. B. O. thesis)
Registered clinics
President's reception
President's banquet
Thursday, April 20
Rocky Mountain Society business meeting and breakfast
General session
Panel discussion of scientific program
Final business meeting
Adjournment

The following officers and committee members were elected:

Officers elected for 1961-1962
President-Elect, J. A. Salzmann
Vice-President, J. Lyndon Carman
Secretary-Treasurer, Earl E. Shepard
Officers nominated for 1962-1963
President-Elect, Earl E. Shepard
Vice-President, E. C. Lunsford
Secretary-Treasurer, Leo B. Lundergan
Elected to fill vacancies on elected committees
Budget and Finance Committee, George H. Siersma (3 years)
Publications Board, Leigh C. Fairbank (3 years)
Public Relations Committee, Norman Hillyer (3 years)
Education Committee, George M. Anderson (3 years)
Research Committee, Ernest H. Hixon (5 years)
Constitution and Bylaws Committee, Donald C. MacEwan (3 years)
Convention-Planning Committee, Robert E. Hennessey (5 years)
Relief Committee, Malcolm R. Chipman (3 years)
Laws and Infractions Committee, William H. Oliver (5 years)
Military Affairs Committee, Robert D. Splain (5 years)
Judicial Council, William A. Giblin (3 years)
Public Health Committee, L. Bodine Higley (5 years)
New Director of A. B. O., Richard Railsback

The meeting was a great success. The various committee members who, in addition to the officers, contributed so much to this success were listed on page 313 of the April, 1961, issue of the JOURNAL. The next meeting will be held April 28 to May 3, 1962, at the Statler Hotel in Los Angeles, California, under the leadership of Dallas R. McCauley.

H. C. P.

Report

REPORT OF REFERENCE COMMITTEE ON THE PRESIDENT'S ADDRESS, FIFTY-SEVENTH ANNUAL MEETING, AMERICAN ASSOCIATION OF ORTHODONTISTS

THIS Committee would like first to express its appreciation to Dr. Humphrey for his diligence, ability, and excellent judgment in discharging his duties as president of the American Association of Orthodontists. The care and thought that he has given to the affairs of the Association are reflected in great part in his address on the current status and accomplishments of orthodontics as a dental specialty.

The Committee joins President Humphrey in paying tribute to Colorado's notable pioneer orthodontists—Albert H. Ketcham, Archie Brusse, and Henry Hoffman—and also to that other loyal Colorado expatriate, H. C. Pollock, Sr., for his skill and ability in guiding the affairs of our excellent JOURNAL through most of its forty-seven years of existence.

We compliment Dr. Humphrey on his appraisal of the Association's contributions to orthodontic education throughout the world, not only by the JOURNAL but also by our efficient qualifying committees. We agree that the Council on Dental Education of the American Dental Association should establish minimum educational standards for specialty training in dental schools. It is encouraging to be able to report that at its February meeting the Council adopted a resolution directing the A. D. A. staff to "develop a plan for surveying the practices and requirements of recognized educational institutions conducting graduate and postgraduate programs in dentistry." This represents the first step in the development of a formal accreditation program for specialty education in the dental schools. The Committee recommends that the Council be urged to consult frequently with the Education Committee and the A. D. A. Liaison Committee of the American Association of Orthodontists on matters pertaining to orthodontic education.

President Humphrey's report on recent accomplishments of the Association is encouraging. This Committee commends particularly the efficiency of the newly established central office under the direction of Secretary Shepard, the successful efforts of the Insurance Committee, the fine work of the Liaison Committee under the guidance of Chairman Gaston, and the competent manner in which President-Elect McCauley conducted the A. A. O. opposition to Resolution 2 at the Los Angeles meeting of the American Dental Association.

The president's recommendations regarding public relations counsel and professional convention management for future meetings deserve serious consideration by the organization. We agree that the Ad Interim Committee should have full authority to assist in the development of a public relations program. However, as this could involve budgetary matters beyond the present authorization in the Bylaws, your Reference Committee recommends that the Ad Interim Committee be directed to outline a proposal relative to the employment of public relations counsel. It is recommended that members of the Ad Interim Committee investigate the public relations problems of the Association, outlining the scope and approximate cost of the proposal, and report their findings at the meeting of the Ad Interim Committee of the Board of Directors in the fall of 1961.

We further recommend that an official certificate of membership from an organization carrying the name of the American Association of Orthodontists would be reassuring to a general public that needs to know who is and who is not recognized as a specialist by his national organization. Only this Association has the history, the traditions, the national and international recognition, and the cultural heritage to discharge this responsibility to society with competence and with authority.

President Humphrey's comments on the American Board of Orthodontics are worthy of repetition: "There is probably no better way to upgrade our specialty than to have it known that a large proportion of our membership has been certified by our American Board." The Committee believes that the highest recognition for a person specializing in orthodontics comes from certification by our own American Board of Orthodontics.

This Committee approves of the recommendations that the central office be in charge of all finances now handled by the Local Arrangement Committee, that formal induction ceremonies for new members be held by the component societies, that all members be urged to apply for Board certification, that the immediate past-president be made a member of the A. A. O. Board of Directors and a member of the Ad Interim Committee, that a suitable plaque be presented to recipients of the Mershon Memorial Award, and that the importance of adequate treatment records for all orthodontic cases be stressed.

The Committee recommends that a travel allowance to reimburse the president for expenses incurred in attending component society meetings be considered. If this is not to be borne by the sectional societies who desire the attendance of the national president at their meetings, provision should be made for this expense to be assumed by the national organization. A decision on whether this consideration should also be extended to the administrative secretary very likely should be postponed. Unquestionably, visits by the president are of great value in keeping component societies informed concerning current problems facing the specialty. Yet they are strenuous and time-consuming, and we are all indebted to Dr. and Mrs. Humphrey for their efforts in developing a sense of national unity by their attendance at virtually all of the sectional meetings.

This Committee agrees that provision should be made for the continuation of the work of the Liaison Committee and understands that the Board of Directors has already taken action in this direction. The Committee also approves the principles underlying the recommendations for a Historical Research Committee, but it believes that further study should be taken to assure compatibility of this proposed committee's duties with those recently provided for the historian and librarian. The Reference Committee recommends that a special committee be appointed to investigate the feasibility of establishing a Historical Research Committee.

On only one item is the Committee reluctant to urge adoption. This concerns the recommendations that a director of the American Board of Orthodontics be made a member of the Board of Directors of the American Association of Orthodontists. Although much is to be said in favor of this measure, there are also certain disadvantages to the arrangement. Pending a more complete study of the recommendation, the Committee respectfully suggests that it be tabled for one year for further consideration by both Boards.

We also join the president in expressing our sincere thanks to every committeeman who has worked to make this meeting successful. In particular, we compliment J. Lyndon Carman, general chairman; J. A. Salzmann, program chairman; George H. Siersma, local arrangements chairman; and Earl E. Shepard, secretary of the Association.

Finally, this Committee, on behalf of the Association, wants to express its deep gratitude to President and Mrs. Humphrey, whom we all know so affectionately as Helen and Bill, for their warm welcome to Denver and for the exceptionally fine meeting and special events program which they have arranged for our benefit and for our pleasure.

Respectfully submitted,

Brooks Bell
Paul Hoffman
B. F. Dewel, Chairman

Department of Orthodontic Abstracts and Reviews

Edited by
DR. J. A. SALZMANN, NEW YORK CITY

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York.

Restorative Dental Materials: By Floyd A. Peyton, D.Sc., Professor and Head, Department of Dental Materials, University of Michigan School of Dentistry; with associates David H. Anthony, D.M.D., Assistant in Research (Dental Materials), Kamal Asgar, Ph.D., Assistant Professor and Research Associate (Dental Materials), Gerald T. Charbeneau, D.D.S., M.S., Associate Professor (Dental Materials and Operative Dentistry), Robert G. Craig, Ph.D., Assistant Professor (Dental Materials), and George E. Meyers, D.D.S., M.S., Associate Professor (Dental Materials and Operative Dentistry), University of Michigan School of Dentistry, Ann Arbor, Michigan. St. Louis, 1960, The C. V. Mosby Company. 542 pages, with 161 illustrations. Price, $10.50.

The structure and properties of matter are presented and the differences between physical and mechanical properties are discussed. All dental materials presently used in restorative dentistry are presented in a concise and authoritative manner.

Stainless steel alloys are discussed from the standpoint of their composition, properties, and related factors. The author points out that "stainless steel should not be considered as a substitute or a replacement for some other materials nor should it be considered to be inferior in quality; instead its properties and general qualities should be understood and the material applied where it seems most appropriate."

While orthodontic materials can hardly be classified as belonging to the category of "restorative materials," this reviewer feels that Peyton and his co-workers would do well to devote a separate chapter to this subject in the future editions which this valuable book is certain to undergo. The orthodontist will find much useful information on metallurgy throughout this text.

The Jaws and Teeth of Primates; Photographs and Commentaries: By W. Warwick James, O.B.E., F.R.C.S., M.Ch., F.D.S., F.L.S., Department of Anatomy, Middlesex Hospital and Dental Research Department, Birmingham University, Birmingham, England. London, 1960, Pitman Medical Publishing Co., Ltd. 328 pages. Price, $15.00.

This book is based primarily upon the excellent exhibit in the section on natural history in the British Museum. A comprehensive study of the jaws and teeth of mammals presents so many varied aspects and problems that the author restricted his book to the primates. Descriptions of the form and types of individual teeth and of the structure of the jaws in man and other primates are presented.

The statement that the temporomandibular joints are the structures upon which the jaws and teeth depend for their relationship to one another is generally not accepted, especially since the temporomandibular joint has become better understood. This joint is more or less rudimentary until the teeth begin to erupt. With the continued establishment of the occlusion of the dentition, the temporomandibular joint takes more definite form.

The dentitions of the various types of primates, including man, are described and beautifully illustrated. Primates are divided into two suborders, the more primitive *Prosimii* and the more advanced *Anthropoidea*. The latter are composed of three well-defined superfamilies, including the *Hominidae*.

In the parts dealing with the *Hominidae*, an account is presented of the jaws and teeth of man in living races and in fossil forms. The importance of a knowledge of the teeth of primates to an understanding of the dentition of man is recognized, although man's teeth should not be looked upon as having developed simply through a sequence of stages from lower to higher forms.

The Eutherian and the tritubercular theories are explained. The teeth of the chimpanzee are cited as resembling most those of man, with the exception of the canines. The chimpanzee's deciduous teeth are relatively larger. The teeth of ancestral forms and primitive races of man, although widely studied, still present difficulty in classification. An interesting chapter on the articular eminence of the temporomandibular joint is included as an appendix. The book is replete with excellent illustrations, and a significant bibliography is included.

The Dentist in Art: By J. J. Pindborg and L. Marvitz. Chicago, 1960, Quadrangle Books, Inc. 144 pages, with 66 illustrations (eight multicolor reproductions), index, bibliography. Price, $12.50.

It seems hardly possible, in the limited space provided by one volume, to convey to the reader the relationships between the arts (painting and sculpture) and dentistry. Photographs of a number of masterpieces some in colors suitable for framing are presented. They include the works of famous artists from antiquity to the present time. J. J. Pindborg is a professor at the Royal Dental College of Copenhagen, Denmark; L. Marvitz is a dental historian who practices dentistry in Copenhagen.

Those interested in the history of art and the history of dentistry will find this a fascinating book.

Noyes' Oral Histology and Embryology, With Laboratory Directions: By Isaac Schour, B.S., D.D.S., M.S., Ph.D., Sc.D., Professor of Histology, Head of Department and Dean, University of Illinois, College of Dentistry, Chicago, Illinois. Eighth edition. Philadelphia, 1960, Lea & Febiger. 440 pages; 345 illustrations on 295 figures and 21 plates, 12 in color. Price, $11.50.

Changes in the eighth edition of this standard text include a discussion of comparative and experimental dental histology. Findings made possible by improvements in electron microscopy and histochemistry and other developments are included. One-fourth of the text is devoted to tooth eruption. This includes the various stages of eruption, from the preparatory stage to the posteruptive changes in the permanent teeth.

Kronfeld is quoted on resorption of permanent teeth, with emphasis on pulpless, replanted, and impacted teeth, proximity to tumors and cysts of the jaws, and exposure to excessive occlusal trauma.

The orthodontist interested in growth and development of the dental organs and of the face in general will find this book of special value.

Bacteriology for Students of Dental Surgery: By R. B. Lucas, M.D., M.R.C.P., D.P.H., Professor of Oral Pathology, University of London, and Pathologist, Royal Dental Hospital of London; and Ivor R. H. Kramer, M.D.S., L.D.S.R.C.S., Reader in Oral Pathology, University of London, and Head of the Department of Pathology, Institute of Dental Surgery and Eastman Dental Hospital. Second edition. Boston, 1959, Little, Brown & Company. 288 pages, with frontispiece in color and 58 text illustrations. Price, $6.00.

This text presents a brief description of the role of bacteria in nature and gives a basic account of the morphology and biology of bacteria. The bacteriology of dental caries and periodontal disease is discussed. A chapter on the bacteriologic examination of oral lesions is presented.

Inter- and Intra-Family Variations in the Facial Profile; An X-ray Cephalometric Investigation on Young Adult Male Sibs: By Karl V. Sarnas, *Odontol. Rev.* **10**: Supp. 4, 1959.

Measurements of sibs of the same family were recorded directly on roentgenograms. The reference points were situated in the median sagittal plane or projected on that plane. In cases of double projections midpoints were constructed and used.

Skeletal reference points were as follows:

Basion (ba) = The perpendicular projection of the anterior border of foramen magnum (endobasion) on a tangent through the lower contour of the foramen.

Gnathion (gn) = The lowest point on the symphysis of the mandible.

Incision inferius (ii) = The midpoint of the contour of the incisal edge of the more prominent lower central incisor.

Incision superius (is) = The midpoint of the contour of the incisal edge of the more prominent upper central incisor.

Incision occlusion (io) = Normal projection of the inferior incision onto the occlusal line.

Infradentale (id) = The highest and most projecting point on the mandibular alveolar process.

Nasion (n) = The anterior point of the nasofrontal suture.

Pogonion (pg) = The anterior projecting point in the chin.

Prosthion (pr) = The lowest and most projecting point of the maxillary alveolar process.

Pterygomaxillare (pm) = A point representing the dorsal contour of the maxilla at the nasal floor level. The point is located on the dorsal contour of the maxilla, upward, forming the anterior border of the pterygopalatine fossa, where it intersects the contour of the hard and soft palates.

Spinal point (sp) = Acanthion (the apex of the anterior nasal spine).

Subspinale (ss) = The posterior point of the outer contour of the maxillary alveolar process.

Supramentale (sm) = The posterior point of the outer contour of the mandibular alveolar process.

Condylion (cd) = The top of the condylar head.

The actual reference point varies with different dimensions recorded, and was therefore defined separately for each of them.

Soft-tissue *reference points* were as follows:

Nasion soft tissue (n_s) = The point of intersection between the nasion sella line (NSL) and the soft tissue profile.

Subspinale soft tissue (SS_s) = The corresponding soft-tissue point of the subspinale (ss_s).

Lip contact (lc) = The anterior point of intersection between the upper and lower red lips (corresponds to Martin's stomion).

Supramentale-soft tissue (sm) = The corresponding soft-tissue point of supramentale (sm).

The requirements of reference points or lines depend upon the type of study being made and the region in question. The most exact points of reference are those established by metallic implants.

Two main positions were defined and studied: the habitual occlusal position and the habitual rest position. The family analysis of variance did not agree with the assumption that the occlusal position is most characteristic of the individual. On the contrary, the findings obtained in skeletal dimensions clearly indicated that the habitual rest position, more than the occlusal position, was an individual characteristic. The habitual rest position showed greater constancy within families. Subsequently, the sibs were found to be more alike in this position.

Two habitual positions (occlusal and rest) of the mandible were subjected to variance analysis in order to select the most suitable position for the present study of the interpretation of biologic associations. The findings provided further evidence that the habitual rest position of the mandible is of higher intraindividual constancy than the habitual occlusal position. Therefore, the rest position is more reliable for various kinds of morphologic studies.

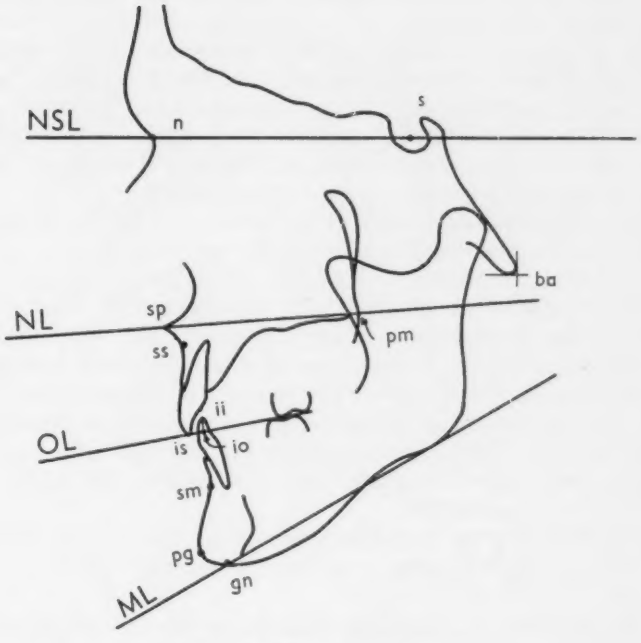
Changes were computed as metric differences of measurements recorded in the habitual rest and habitual occlusal positions of the mandible. Significant changes were found at both the chin and the mandibular condyle, suggesting that the whole mandible was transposed during the movement from the habitual rest to the habitual occlusal position.

The further analysis of changes at the chin and mandibular condyle showed that changes in both the horizontal and the vertical directions were intercorrelated within and between the two parts. Thus, the change in the anterior lower face height (sp′-gn change or freeway space) was found to be associated not only with changes at the chin but also with changes at the mandibular condyle.

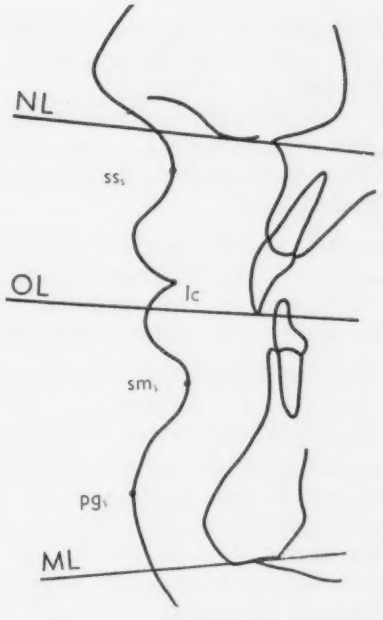
The analysis of regressions showed that the mandible was transposed more in a vertical than in a sagittal direction.

The lip morphology was found to be associated with the morphology of the underlying structures and in particular with the position of the upper incisor. Thus, as a rule, a retruded upper incisor (NL-+1) was seen in association with a large upper lip height and thickness, a high position of stomion above the OL (lip contact vertical), and a large relative protrusion of the lips. Furthermore, there were positive associations between the upper and lower lip heights and the anterior lower face height (sp-gn). The latter did not show any correlation at all to the thickness of the lips. However, when this dimension (sp′-gn) was recorded in the habitual occlusal position of the mandible, associations were re-established.

The methodological procedures in obtaining the data are discussed with respect to their influence upon the result of the biometric analysis. This was the case, for instance, in reference to the association between the lip contact vertical and the upper incisor angle, which was brought about by the position of the occlusal line (OL). The movement of the mandible from the habitual



Reference points—skeletal.



Reference points—soft tissue.

rest position to the occlusal position could apparently establish the above-mentioned associations between the thickness of the lips and the anterior lower face height (sp′-gn).

The position of the upper incisor (NL-+1) in relation to the lips was further discussed in an analysis of two extreme groups, the one exhibiting extreme protrusion and the other showing extreme retrusion of the incisors. The limit was drawn at about plus or minus 2 standard deviations. As a rule, the results confirmed the previous findings, although the significance of the established association to the upper lip height could be questioned.

The vertical overbite was found to be correlated to the anterior lower face height (sp′-gn) and to the depth of lower lip curvature, but not even a probable correlation could be obtained between these two dimensions in either of the two mandibular positions studied. It was suggested that this was due to the lack of association between the lower lip height and the depth of lower lip curvature or vertical overbite. Thus, a small anterior lower face height (sp′-gn) may be found with a depth of lower lip curvature of any size. Consequently, depth of lower lip curvature is of somewhat questionable clinical value in assessing skeletal and/or dental morphology. This was the case regardless of whether depth of lower lip curvature was recorded in the habitual rest or the occlusal position of the mandible.

The analysis of extremes demonstrated great individual variations. Thus, a pronounced mentolabial furrow was not necessarily observed in association with a closed bite.

Analysis of changes in the lips following the mandibular transposition from the habitual rest to the habitual occlusal position were revealed that both lips, particularly the lower lip, were affected.

Changes in the lips have also been related to the dentofacial complex, but positive findings have been obtained almost solely in relation to the horizontal and vertical overbites.

As as rule, upper and lower lip changes have been found to be intercorrelated. This is also the case when the lip and dentofacial changes have been studied in relation to each other.

The variance analysis disclosed a higher degree of sib likeness in the habitual rest position of the mandible with reference to the lower lip.

The following associations were studied with the aid of the "family method" and the results are summarized here:

1. *The association between the medial (n-s-ba) and lateral (alpha angle) cranial base angles.* The findings showed that neither of the two angles had any influence on the variation of the other, whether studied in the habitual rest or the occlusal position of the mandible.

2. *The association between the beta and gonial angles of the mandible.* These angles were found to change the variability of each other. This was interpreted as a bilateral causal relationship.

3. *The association between the anterior lower face height (sp′-gn) and the vertical overbite.* It was found that the presence of a closed bite may have a certain influence on the variability in lower face height. On the other hand, the variability in vertical overbite was apparently not affected by that of the anterior lower face height. A unilateral causal relationship was thus suggested.

When this association was studied in the habitual occlusal position of the mandible, a bilateral relationship was observed. Consequently, in this position variability in the vertical overbite can be affected or influenced by that of the anterior lower face height (sp′gn).

4. *The associations between the depth of lower lip curvature and (a) the horizontal overbite and (b) the vertical overbite was studied together, since the latter variables are intimately correlated.* The findings were negative in the sense that they did not permit an interpretation of the "cause-and-effect" relationship in these associations.

The lower lip and the position of the incisors (horizontal overbite) may have a certain influence on one another's variability.

News and Notes

1962 Ketcham Awards

The American Association of Orthodontists and the American Board of Orthodontics have voted to confer the Albert H. Ketcham Memorial Awards for 1962 upon Mr. Charles H. Bolton of Cleveland, Ohio, and Dr. C. Edward Martinek of Detroit, Michigan.

The Ketcham Award is regarded as the highest recognition conferred by American orthodontists. It was established in 1936 by the American Board of Orthodontics in collaboration with the American Association of Orthodontists and is bestowed in appreciation of the recipient's active interest in and support of the progress of orthodontics and dental health in general.

The 1962 Awards will be presented at the fifty-eighth annual meeting of the American Association of Orthodontists in Los Angeles, California, on April 29, 1962.

American Board of Orthodontics

The next meeting of the American Board of Orthodontics will be held at the Statler Hotel in Los Angeles, California, Monday through Saturday, April 23 to 28, 1962. Orthodontists who desire to be certified by the Board may obtain application blanks from the secretary, Alton W. Moore, University of Washington, School of Dentistry, Seattle 5, Washington.

Applications for acceptance at the Los Angeles meeting, leading to stipulation of examination requirements for the following year, must be filed before March 1, 1962. To be eligible, an applicant must have been an *active* member of the American Association of Orthodontists for at least two years.

Pacific Coast Society of Orthodontists

The Pacific Coast Society will hold its annual meeting Aug. 6 to 10, 1961, in Seattle, Washington, under the presidency of E. Allen Bishop, 703 Cobb Bldg., Seattle, Washington.

Denver Summer Meeting for the Advancement of Orthodontic Practice and Research, Inc.

The twenty-fourth annual Denver Summer Meeting will be held July 30 to Aug. 4, 1961, at Writer's Manor in Denver, Colorado. The following outstanding program has been arranged by the Board of Trustees:

Maury Massler, D.D.S., M.S.

1. Oral Habits: Origin, Evolution, and Management
   - A. Sucking Habits
   - B. Biting Habits
   - C. Tongue and Lip Habits

2. The Adolescent Looks at Orthodontia
3. Radiographic Interpretations of Bone Changes Incident to Tooth Movement
   A. Changes in the Lamina Dura
   B. Estimating the Resorption Potential of Bone and Root

Robert M. Ricketts, D.D.S.

Cephalometrics

Harry W. Tepper, D.D.S.

Dynamic Functional Therapy—The Orthodentor by Bimler
   A. Philosophy of Functional Therapy
   B. Mode of Action
   C. Advantages for Orthodontist and Patient

Joseph A. Fitzpatrick, Ph.D., and David Stone, B.S., D.D.S.

1. Adverse Swallowing, a Pattern of Tongue Thrusting Related to Dental Malformation
2. Causes, Recognition, and a Treatment Using the Speech Therapist to Restore the Muscles and Patterns in Swallowing

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West Coast Groups Hold Joint Breakfast Meeting

The Southern California Society of Dentistry for Children and the Southern Component of the Pacific Coast Society of Orthodontists held a joint breakfast meeting on the morning of April 24, 1961, at the Biltmore Hotel in Los Angeles, California. John R. Abel, president-elect of the American Dental Association, spoke on "Specialties in the American Dental Association."

First Australian Orthodontic Congress

The Australian Society of Orthodontists will conduct the first Australian Orthodontic Congress in Sydney, Australia, Aug. 9 to 11, 1961.

Program

President's Address. R. Y. Norton.
The Orthodontic Situation (Stanley Wilkinson Oration). P. R. Begg.
Clinical Evaluation of Chin Cups; a Preliminary Report. C. J. Armstrong.
Discussion Leader. A. G. Parker.
Case Reports. K. T. Adamson and W. J. Mackie.
Subluxation of Vomeromaxillary Articulation. R. G. Henry.
Surgery Arrangement. R. H. Wallman.
Some Metallurgical Aspects of Orthodontic Stainless steel. J. V. Wilkinson.
Discussion Leader. K. Godfrey.
Examination and Control of Space. K. F. Henderson and J. F. McGibbon.
Discussion and Case Report. D. F. Spring.
Functional Anatomy of Muscles. A. F. Roche.
Discussion Leader. B. G. McLean.
Twin Wire Philosophy. V. P. Webb.
Discussion Leader. R. W. Halliday.
Vertical Dimension Overbite and Labial Segment Stabilization. L. M. Smart.
Discussion Leader. A. S. Burgess.
Symposium—Extraoral Anchorage. S. Seward, leader.
Orthodontics, 1971. K. T. Adamson and A. T. Taylor.
The above program will be followed by an extensive program of table clinics.

Information and application forms can be obtained from Mr. J. F. Reading, Honorary Secretary, Australian Society of Orthodontists, 149 Macquarie St., Sydney, Australia.

Loyola University

Loyola University School of Dentistry, Chicago, announces that a postgraduate course entitled "Light Wire Differential Forces in the Treatment of Dental Malocclusions" will be given July 9 to 15, 1961, in Chicago, Illinois. The course will be under the direction of Joseph R. Jarabak, Professor and Chairman of Orthodontics, and his staff.

E. J. Forrest Named Dean of University of Pittsburgh School of Dentistry

Edward J. Forrest, associate dean of the University of Illinois College of Dentistry, has been appointed dean of the University of Pittsburgh School of Dentistry, effective Sept. 1, 1961.

Dr. Forrest is currently director of postgraduate education and professor of orthodontics at the University of Illinois College of Dentistry. He is also a member of the Committee on Education of the American Association of Orthodontists.

Washington University

A course in the labiolingual technique will be given July 23 to 29, 1961, at the Washington University School of Dentistry in St. Louis, Missouri. The course will be under the direction of Oren A. Oliver and staff.

Admission is limited to persons in the exclusive practice or teaching of orthodontics whose experience and background qualify them for the course.

Tentative Schedule for Mission to USSR

According to a recent release from the American Dental Association, the following tentative itinerary for the United States dental mission to Russia has been announced by A.D.A. President Charles H. Patton:

June 3 to 7 Moscow
June 8 to 10 Leningrad
June 11 to 14 Kiev
June 16 to 18 Tiflis
June 19 to 21 Sochi

On June 22 the eight-man group will return to Moscow for further visits to that city's dental, scientific, and cultural centers.

The dental mission is made up of the following: Charles H. Patton, president of the American Dental Association; John R. Abel, president-elect of the American Dental Association; Francis A. Arnold, Jr., director of the National Institute of Dental Research; Thomas J. Hill, Brecksville, Ohio; John W. Knutson, chief dental officer of the United States Public Health Service; Arthur F. Schopper, Kansas City, Missouri; Gerald D. Timmons, dean of Temple University School of Dentistry; and Harold Hillenbrand, secretary of the American Dental Association.

American Orthodontists to Participate in European Congress

B. F. Dewel of Evanston, Illinois, T. M. Graber of Kenilworth, Illinois, and S. Kloehn of Appleton, Wisconsin, have been invited to appear on the program of the thirty-seventh congress of the European Orthodontic Society in Bologna, Italy, Sept. 7 to 11, 1961. The preliminary scientific program includes the following:

PERVERTED MUSCULAR FUNCTION IN MALOCCLUSIONS. T. M. GRABER.

THE DANGERS AND PITFALLS OF SERIAL EXTRACTION. J. SEN HEATH.

Round-table discussion: Posttreatment Appraisal of the Orthodontic Results.

Orthodontic Treatment in the Mixed Dentition With Edgewise Appliance. B. F. Dewel.

An Appraisal of Results of Treatment of Class II Malocclusion With Extraoral Cervical Forces. S. Kloehn.

Social events will include the president's reception at the S. Martino Castle, a civic reception at the City Hall, a reception by the Provincial Administration at Palazzo Malvezzi, an all-day Sunday excursion to the Adriatic Seacoast, a banquet and ball at the Sporting Club, and a post-Congress excursion to Ravenna. The program planned for the ladies includes a welcoming reception, a tour of the city of Bologna, a fashion show, a visit to the Buton Distilling Plant, an excursion to Ferrara (luncheon included), and a visit to the art gallery.

Association of American Women Dentists

The Association of American Women Dentists will meet on Oct. 15 and 16, 1961, at the Warwick Hotel in Philadelphia, Pennsylvania.

Notes of Interest

Edwin B. Crenshaw, D.D.S., announces the opening of his office at 204 KnoWel Bldg., Knowles at Welbourne, Winter Park, Florida, practice limited to orthodontics.

Frank P. Iuorno, D.D.S., announces the opening of his office at 1424 Genesee St., Utica, New York, practice limited to orthodontics.

Dr. Vincent V. LaBruna, who has moved his office to 30 East 60th St., New York, New York, announces that his practice is now limited to orthodontics.

John F. Manera, D.D.S., announces the opening of his office at 102 Waterman St., Providence, Rhode Island, practice limited to orthodontics.

Irwin Steuer, D.D.S., announces the removal of his office to 9400 Brighton Way, Beverly Hills, California.

Forthcoming meetings of the American Association of Orthodontists:

1962—Statler Hotel, Los Angeles, California, April 28 to May 3.
1963—Hotel Fontainebleau, Miami Beach, Florida, May 5 to 9.
1964—Palmer House, Chicago, Illinois, May 10 to 14.
1965—Dallas Statler-Hilton, Dallas, Texas, April 25 to 30.

OFFICERS OF ORTHODONTIC SOCIETIES*

The AMERICAN JOURNAL OF ORTHODONTICS is the official publication of the American Association of Orthodontists and its component societies. The Editorial Board of the JOURNAL is composed of a representative of each of the component societies.

American Association of Orthodontists

(Next meeting April 28—May 3, 1962, Los Angeles)

President, Dallas R. McCauley — 410 South Beverly Dr., Beverly Hills, Calif.
President-Elect, J. A. Salzmann — 654 Madison Ave., New York, N. Y.
Vice-President, J. Lyndon Carman — 501 Republic Bldg., Denver, Colo.
Secretary-Treasurer, Earl E. Shepard — 225 South Meramec, Clayton, Mo.

Central Section of the American Association of Orthodontists

(Next meeting Oct. 1-3, 1961, Minneapolis)

President, Henry E. Colby — 1850 Medical Arts Bldg., Minneapolis, Minn.
Secretary-Treasurer, Kenneth E. Holland — 1016 Sharp Bldg., Lincoln, Neb.
Director, G. Hewett Williams — 811 Elm St., Winnetka, Ill

Great Lakes Society of Orthodontists

(Next meeting Nov. 12-17, 1961, Miami Beach)

President, Paul V. Ponitz — 914 Security Bank Bldg., Battle Creek, Mich.
Secretary, Edward A. Cheney — 2900 Grand River, Lansing, Mich.
Director, Harlow L. Shehan — 601 Jackson City Bank Bldg., Jackson, Mich.

Middle Atlantic Society of Orthodontists

(Next meeting Oct. 1-3, 1961, Atlantic City)

President, Paul V. Reid — Medical Arts Bldg., Philadelphia, Pa.
Secretary-Treasurer, Charles S. Jonas — Mayfair Apts., Atlantic City, N. J.
Director, Louis E. Yerkes — 825 Linden Ave., Allentown, Pa.

Northeastern Society of Orthodontists

(Next meeting Oct. 29-31, 1961, Rochester, N. Y.)

President, Irving Grenadier — 888 Grand Concourse, New York, N. Y.
Secretary-Treasurer, David Mossberg — 36 Central Park S., New York, N. Y.
Director, Norman J. Hillyer — 230 Hilton Ave., Hempstead, L. I., N. Y.

Pacific Coast Society of Orthodontists

(Next meeting Aug. 6-10, 1961, Seattle)

President, E. Allen Bishop — 703 Cobb Bldg., Seattle, Wash.
Secretary-Treasurer, Warren A. Kitchen — 2037 Irving St., San Francisco, Calif.
Director, William S. Smith — 2530 Bissell Ave., Richmond, Calif.

Rocky Mountain Society of Orthodontists

President, Louis J. Williams — 843 South Center St., Casper, Wyo.
Secretary-Treasurer, Hubert J. Bell, Jr. — 230 Mercantile Bank Bldg., Boulder, Colo.
Director, Ernest T. Klein — 707 Republic Bldg., Denver, Colo.

Southern Society of Orthodontists

(Next meeting Nov. 5-8, 1961, St. Petersburg)

President, Charles E. Harrison — 362 Sixth St., S., St. Petersburg, Fla.
Secretary-Treasurer, William H. Oliver — 1915 Broadway, Nashville, Tenn.
Director, Boyd W. Tarpley — 2118 Fourteenth Ave., S., Birmingham, Ala.

Southwestern Society of Orthodontists

(Next meeting Oct. 22-25, 1961, Dallas)

President, Bibb Ballard — 7713 Inwood Rd., Dallas, Texas
Secretary-Treasurer, Tom M. Matthews — 8215 Westchester Dr., Dallas, Texas
Director, Nathan Gaston — 701 Walnut St., Monroe, La.

American Board of Orthodontics

(Next meeting April 23-28, 1962, Los Angeles)

President, J. A. Salzmann — 654 Madison Ave., New York, N. Y.
Vice-President, B. F. Dewel — 708 Church St., Evanston, Ill.
Secretary, Alton W. Moore — University of Washington School of Dentistry, Seattle, Wash.
Treasurer, Paul V. Reid — 1501 Medical Arts Bldg., Philadelphia, Pa.
Director, Frank P. Bowyer — 608 Medical Arts Bldg., Knoxville, Tenn.
Director, Nathan G. Gaston — 701 Walnut St., Monroe, La.
Director, Richard M. Railsback — 1333 Grand Ave., Piedmont, Calif.

*In order to keep this list up to date, the editor depends on the various sectional editors to notify him immediately of changes in officer personnel.

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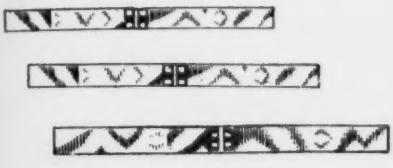

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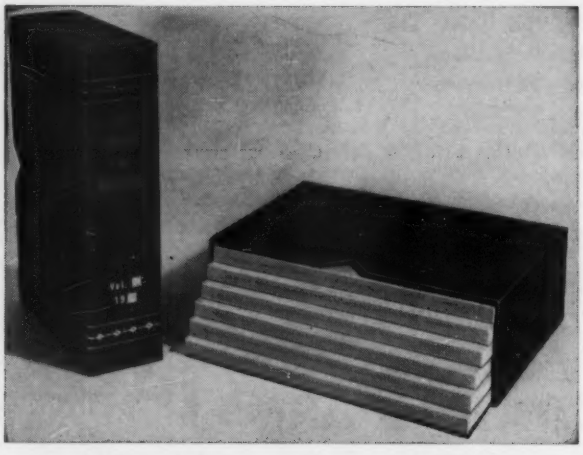

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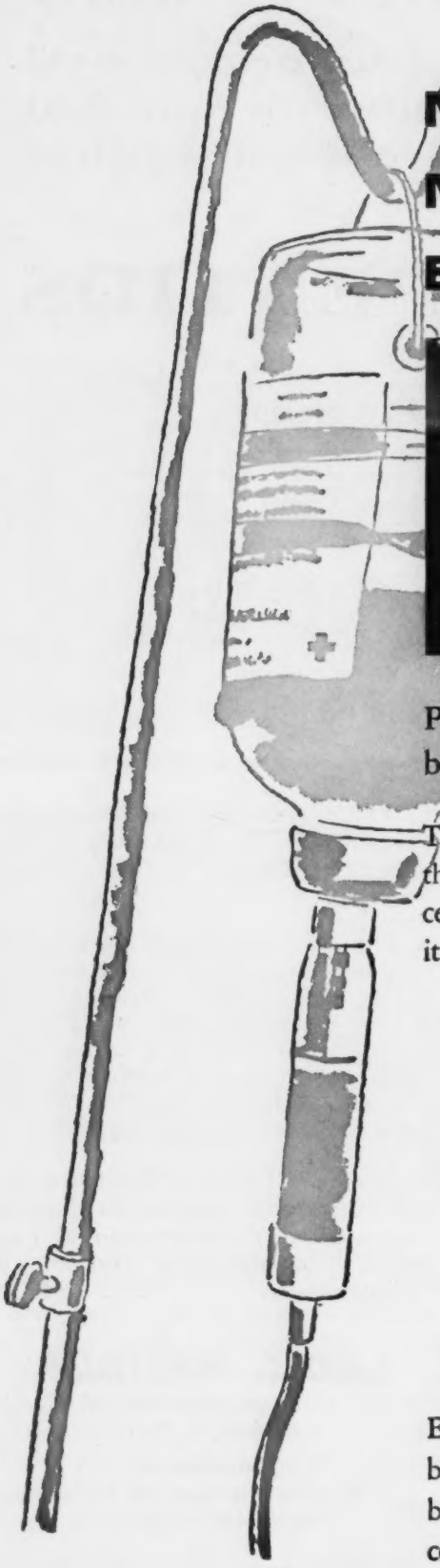

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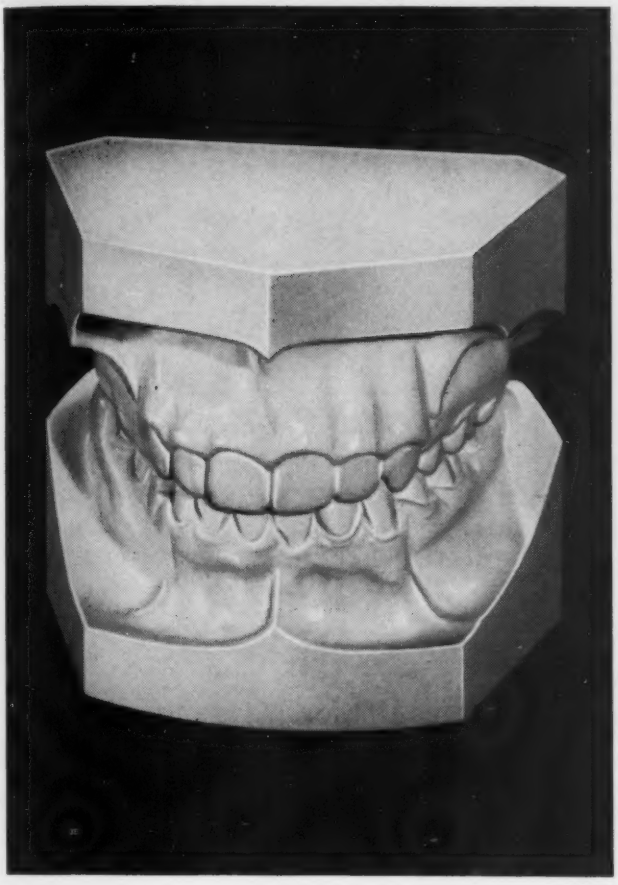

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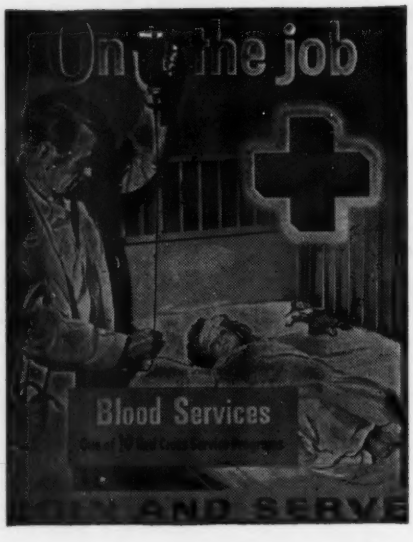

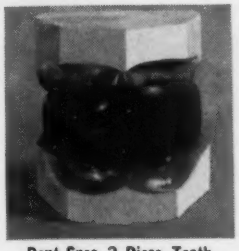

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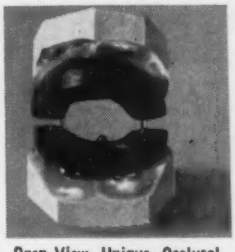

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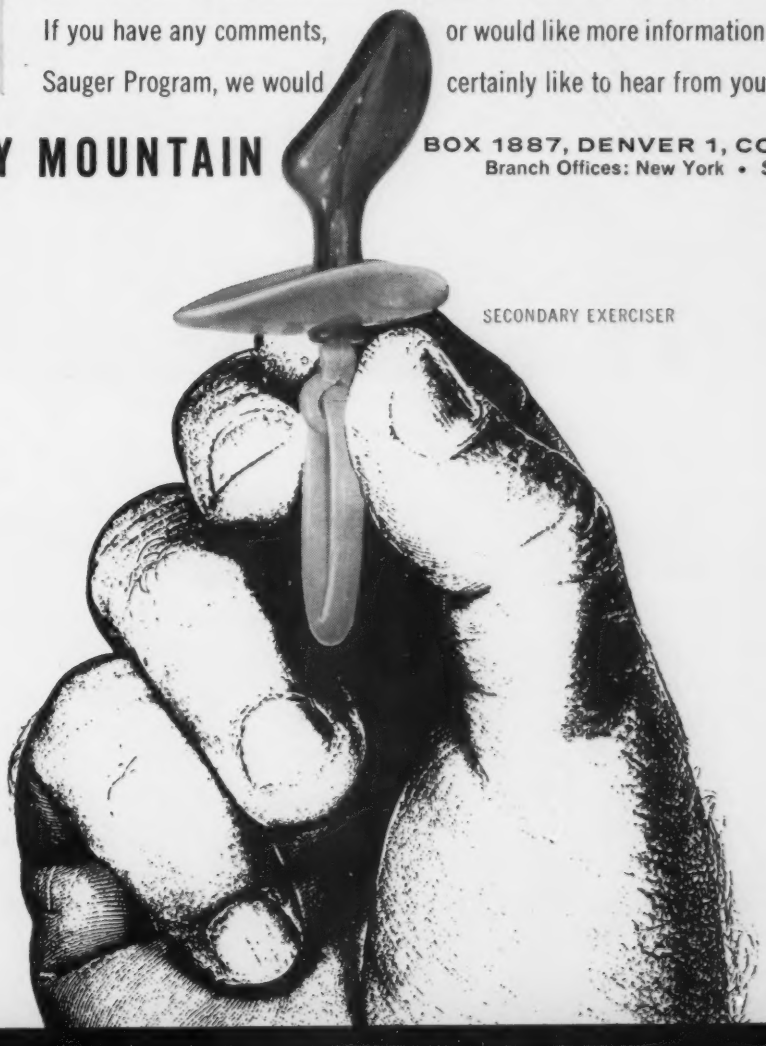

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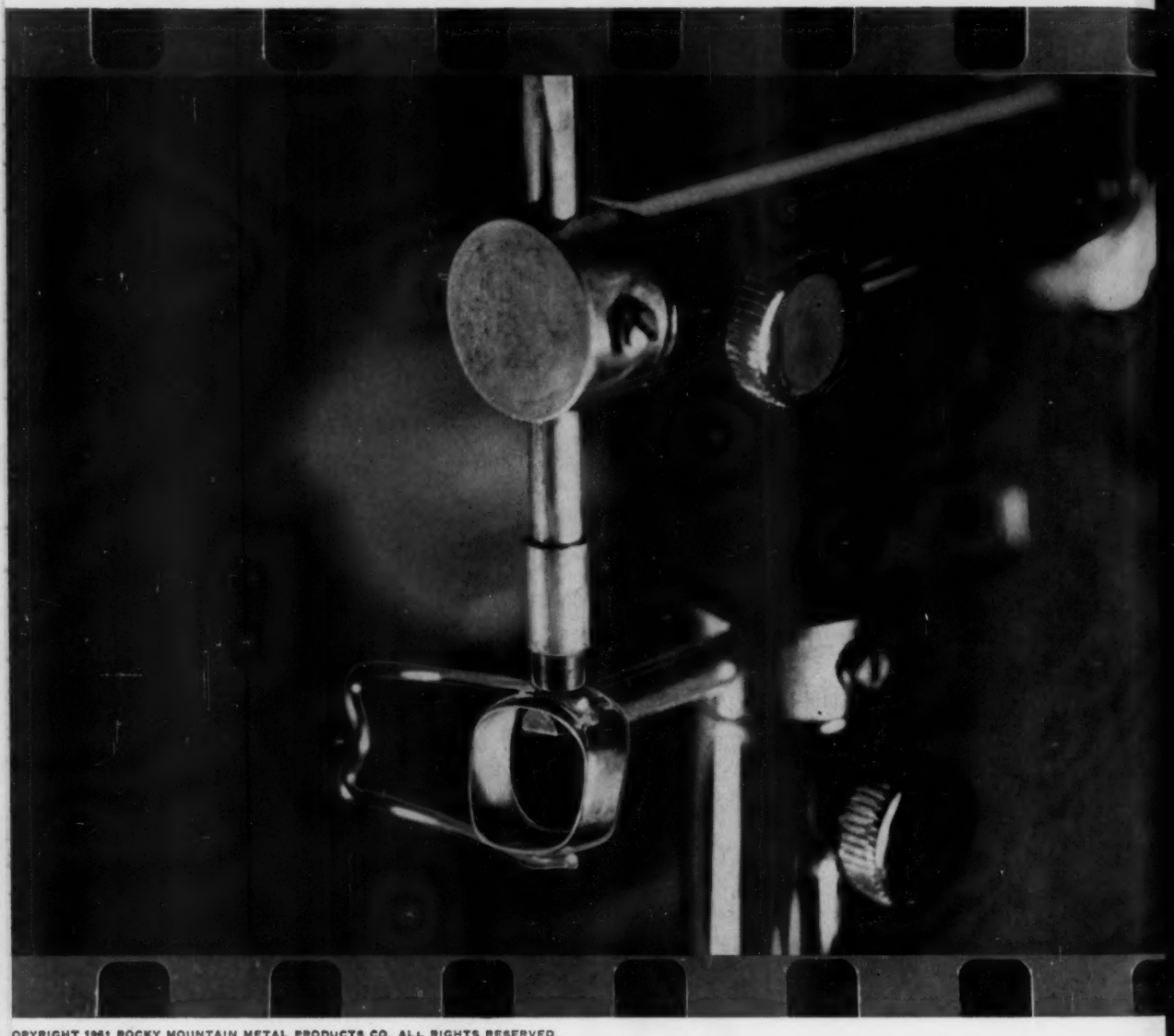

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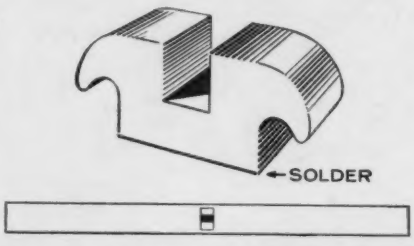

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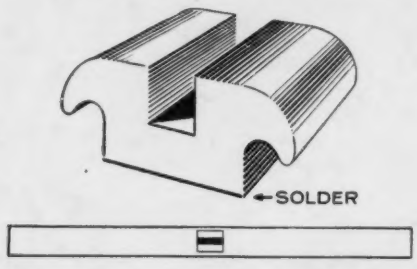

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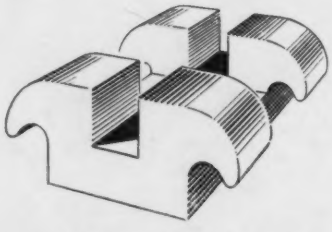
M 455



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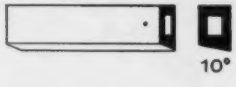

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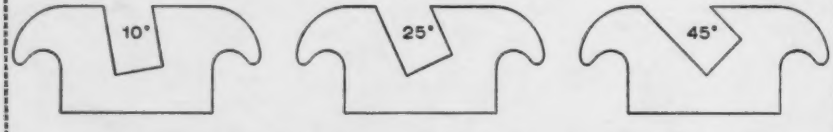

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